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Self-Anchored Suspension Bridge in Missouri

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Old Concrete Road hows Record Service

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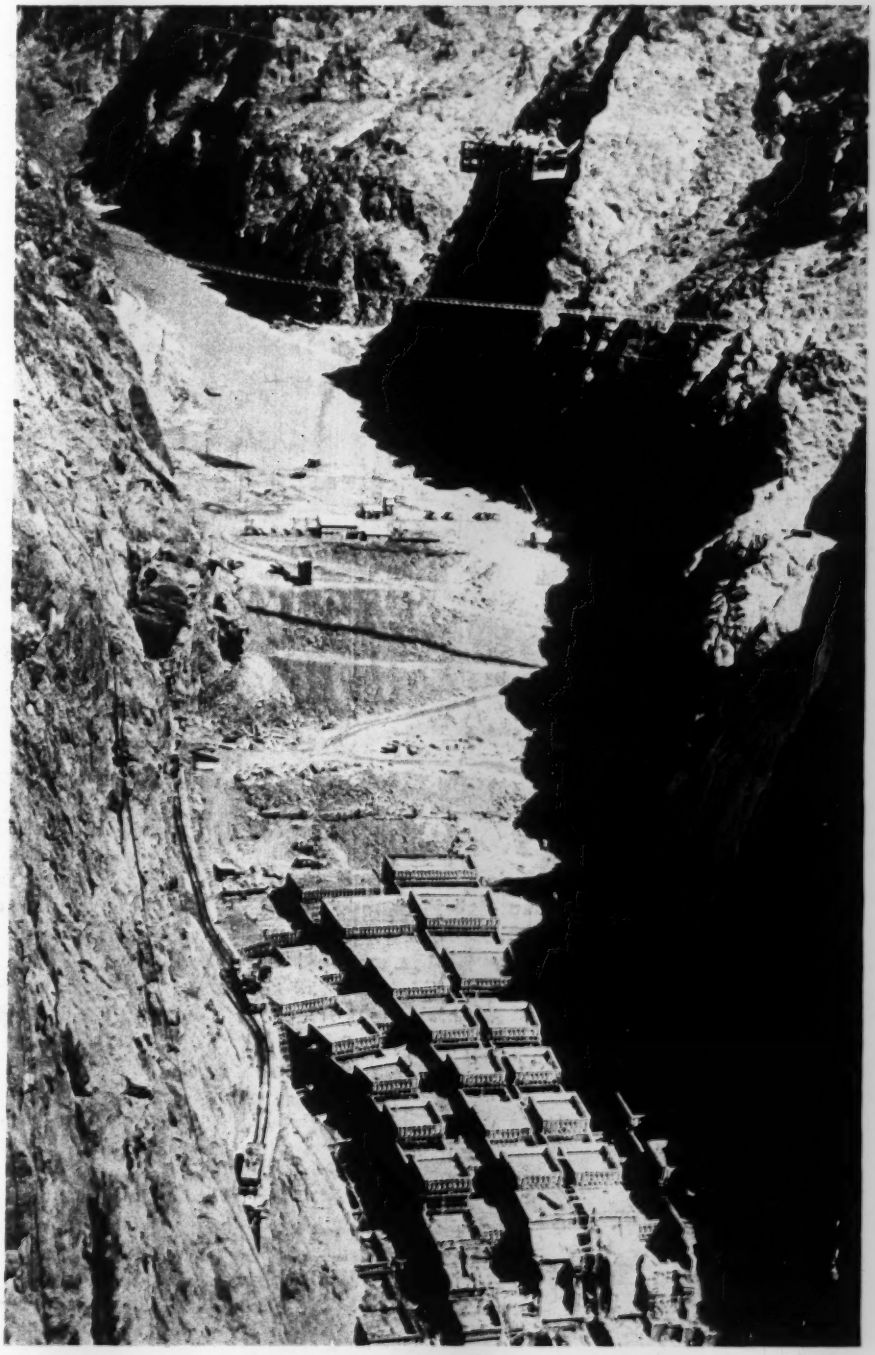
Convention Report of New England ate Works Association



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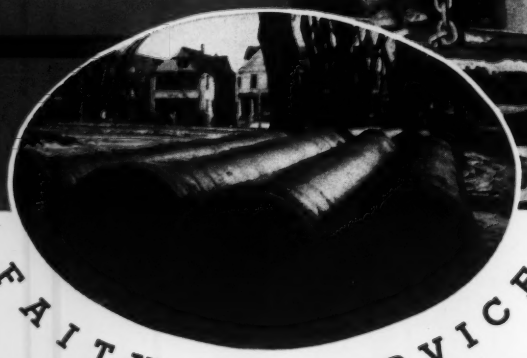

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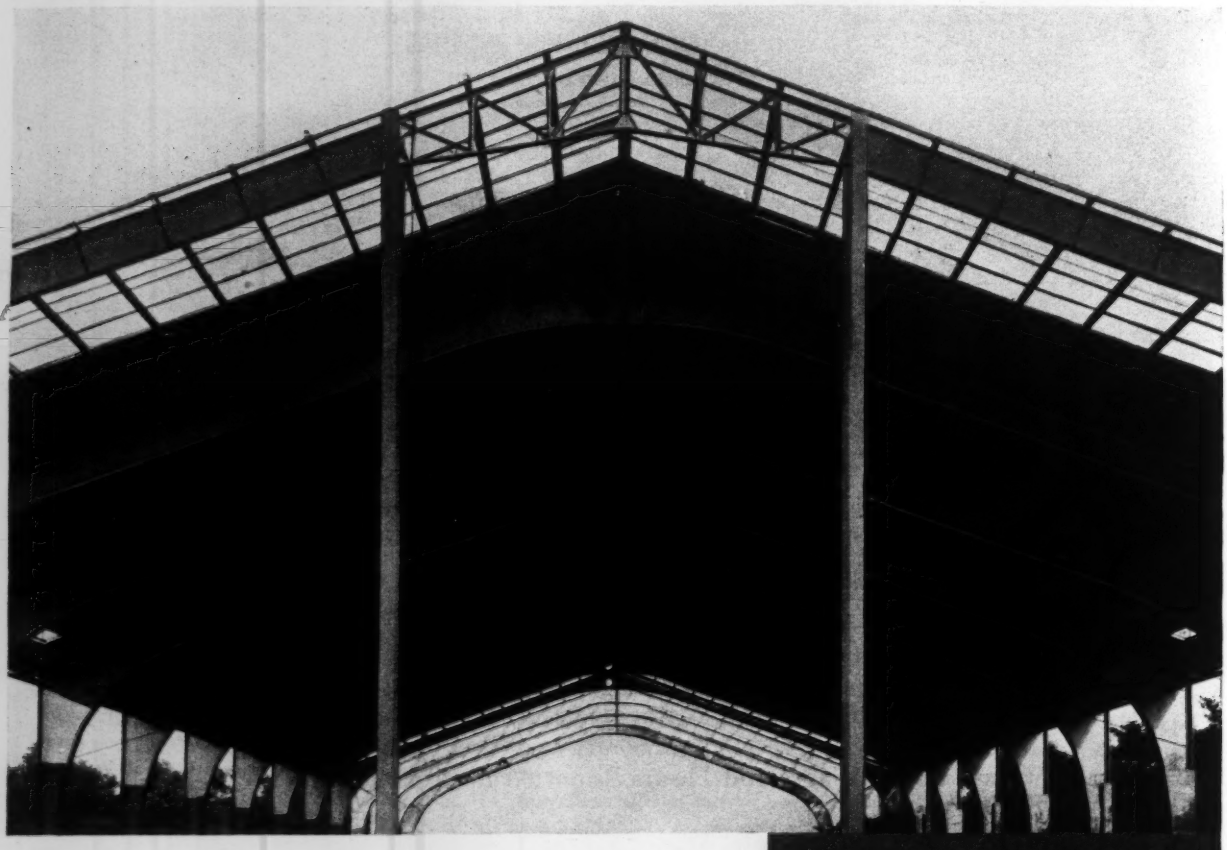

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Self-Anchored Suspension Bridge Built in Missouri

Crossing an arm of the Lake of the Ozarks on a farm-to-market type road and having a main span of 225 ft., the unusual structure was built for $37,000—Stiffening girders are 33-in. rolled beams, and cables are prestressed twisted strands

By Howard Mullins
Missouri State Highway Department, Jefferson City, Mo.

ONE OF the most notable recent projects of the Missouri state highway department is the completion of a self-anchored suspension bridge of 450-ft. total length and 225-ft. main span, located in Camden County, about 100 miles south of Jefferson City, on one of the so-called "farm-to-market" routes. It spans the inundated bed of the Little Niangua River, now an arm of the Lake of the Ozarks, formed by the construction of Bagnell Dam, and is believed to be the fourth self-anchored suspension bridge built in the United States, the other three being the Sixth, Seventh and Ninth St. bridges over the Allegheny River at Pittsburgh, Pa. The new bridge is the first stiffened suspension bridge built in Missouri since the completion in 1890 of the Grand Ave. braced-cable suspension structure in St. Louis. Unique features of the design include the application of prestressed strands to the self-anchored type; an unusual arrangement of the strands in the cable; the use of rolled-beam sections for the stiffening girders; the use of a built-up or laminated cable clamp; and the method of handling the expansion movement. The principal dimensions are shown in Fig. 2.

Fig. 1—Short-span self-anchored suspension bridge built by Missouri highway department on a farm-to-market road.

The funds available for the construction of the bridge were limited. It was therefore desirable to select the most economical layout and since the bridge is located in a somewhat scenic region, with much

camping and boating near by, it was felt that a design of reasonable esthetic fitness should be used. With these considerations in mind, comparative designs were made using 50-ft. I-beams throughout, three 150-ft. truss spans with one 70-ft. girder span, and an unstiffened suspension layout with the same span arrangement as was used for the self-anchored layout, with sand-filled anchorages.

The I-beam layout was entirely unsuited from an esthetic viewpoint. The truss layout was little better. The unstiffened suspension layout was considered inadequate for a bridge of such light weight and slender proportions. The self-anchored type proved the most economical and was adopted. One of the outstanding features of the self-anchored type is that the greater part of the construction is placed in the superstructure, where it can be seen, and not in expensive unseen anchorages. It is believed that the design as built presents a reasonably pleasing appearance.

The very low cost of the design is believed to be ample justification for its adoption. The total cost of the bridge was $36,914 for a length of approximately 523 ft. This gives a cost of $70.50 per linear foot, or a cost of $3.52 per square foot of floor area.

Basis of design

The bridge was designed for a live load of H10 on one lane only, with an impact allowance not to exceed 30 per cent of the live load. For the design of the towers, which are the only part of the structure stressed by uniform change of temperature, a range of 60 deg. was assumed. The wind load used was 30 lb. per sq.ft. on 1½ times the vertical projection of the structure.

For the concrete substructure a unit stress was used of 500 lb. per sq.in. direct stress and 650 lb. per sq.in. bending. The floor system was proportioned for a working stress of 18,000 lb. per sq.in. in bending. The stress in the stiffening girders was limited to 18,000 lb. per sq.in. for bending and direct stress combined, due to $D+L+I$, and 20,000 lb. per sq.in. due to $D+L+I+$ wind. The towers were proportioned for a working stress of 20,000 lb. per sq.in. due to $D+L+I+$temp.$+$wind$+$ bending. All other parts were proportioned for a basic unit stress of 18,000 lb. per sq.in., reduced for compression. The cable was proportioned for a working stress of 65,000 lb. per sq.in.

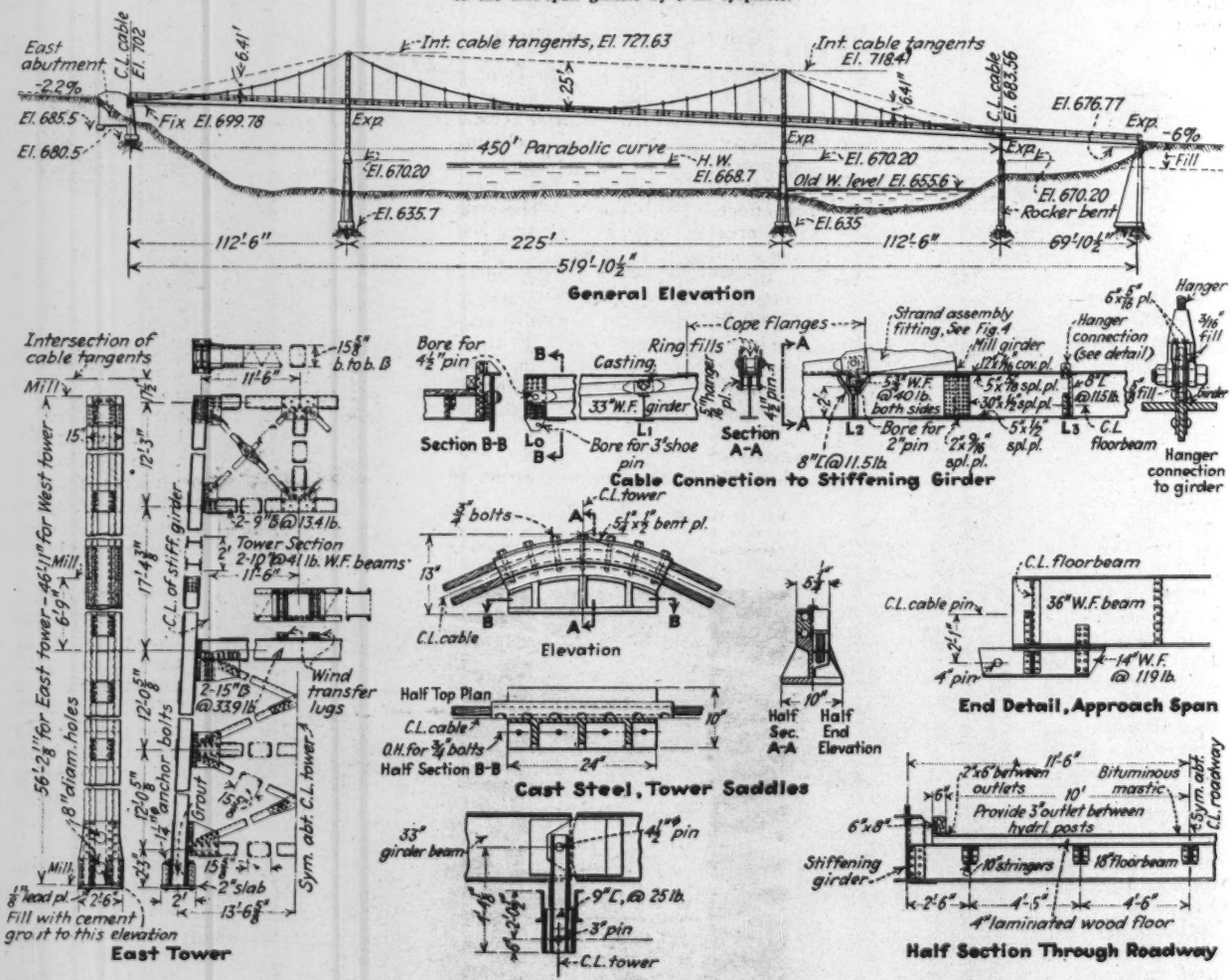
The design was prepared using the assumptions usually made in stiffened suspension-bridge design where the elastic theory is employed. The design formulas were set up by the method of least work to include the lack of symmetry of the structure and the work done by the stiffening girder.

Substructure

The east abutment is of U type in which the walls are carried about 2 ft. below ground line at the front, and only the columns at each corner and at the center of the tie beams in the rear are carried to rock.

The two main piers consist of two columns of uniform section converging into a rectangular section under the coping and connected by a pointed-arch

Fig. 2—Elevation and details of 225-ft.-span self-anchored suspension bridge. Stiffening girders are 33-in. rolled sections hinged at the towers, which are of fixed-base flexible type. Cables consist of four 1¼-in. twisted wire strands, pin-connected to the side-span girders by 9-in. eyeplates.



web. The footings are founded on rock 25 ft. below pool stage of the lake.

The rocker bent pier is an ordinary rectangular framed bent founded on rock and extended to 1.5 ft. above extreme high water.

The west abutment is of open type construction with back wall and wings just sufficient to retain the fill. It also is founded on rock.

Girders, floor and towers

The stiffening girder for a self-anchored suspension bridge is one of the major stress-carrying members. Great care therefore must be used in its proportioning and in the selection of suitable working stresses.

As no great rigidity was necessary for the traffic to be cared for, the stiffening girders were made of 33-in. rolled sections throughout, giving a ratio of depth to main span of about 1/82. In the side spans the girders weigh 141 lb. per foot, and in addition are provided with a coverplate over the top flange for the central 50 ft. The main span girders consist of 125-, 152- and 141-lb. sections. The girders are hinged at the towers and connected thereto as shown in Fig. 2 to permit longitudinal and prevent vertical movement.

At each floor beam the girder is stiffened by an 8-in. channel. The top flange of the stiffening girders at these points is slotted each side of the web to receive the hanger connection plates.

The floor consists of 2x4-in. creosoted pine laid on edge and fastened with metal clamps to the stringers, which are 10-in. W.F. sections spaced 4½ ft. These stringers frame into 18-in. W.F. section floor beams spaced 12.5 ft. on centers and framed into the stiffening girders.

The towers are of the fixed-base flexible type, with legs made up of two 10-in. W.F. sections connected by stay plates. Field splices are placed just above the elevation of the stiffening girders. The wind reaction from the stiffening girders is delivered to the horizontal tower strut beneath the floor through lugs, as shown in the tower elevation, Fig. 2.

It was not desirable or practical to fix the structure to either of the slender towers, and since the depth of the foundations on the west end would require the addition of material if a fixed connection were used there, it was decided to make the broad, stable east abutment the fixed point and provide for expansion movement of the girders through the towers to the west abutment. This movement induces considerable bending in the towers, which was considered in their design. Provision is made at the west abutment for the expansion movement of the full length of the bridge.

Under the west end of the suspension structure and supporting the approach span a rocker bent was used. The wind load from the approach span is

Fig. 3—Bridge roadway 20 ft. wide consists of 2x4-in. creosoted pine boards laid on edge.

delivered to the end floor beam of the side span and then to the rocker bent through two 16-in. beam sections riveted between the floor beam and the top strut of the rocker bent. The rocker motion of the bent induces bending in the webs of these beam sections.

In order to continue the lines of the stiffening girders for the full length of the bridge, 36-in. W.F. sections are used for the girders of the approach span, with the same floor construction as was used for the suspension structure.

Cables, hangers and details

Each cable consists of four 1¼-in. galvanized strands (Fig. 5). The arrangement used makes each strand accessible for inspection and painting, eliminates the necessity of wrapping and makes possible the design of a very compact and effective cable clamp. The strands were prestressed and were specified to have a minimum modulus of 24,000,000 up to 50 per cent of the ultimate strength, which was shown by test to be 225,000 lb. on a gross metallic area of 1 sq.in. At approximately 30 ft. from the end of the side span the strands terminate in a modified Roebling compact strand assembly. From this point to the end of the side span the cable consists of two 9-in. eyeplates, one on either side of the stiffening girder web.

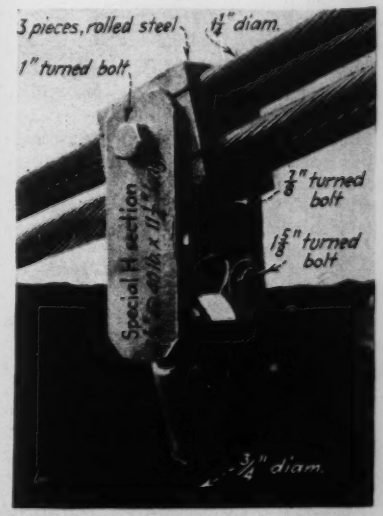
Fig. 4—Assembly detail where wire strands connect to eyeplates, which are pin-connected to the side-span girders as shown in Fig. 2.

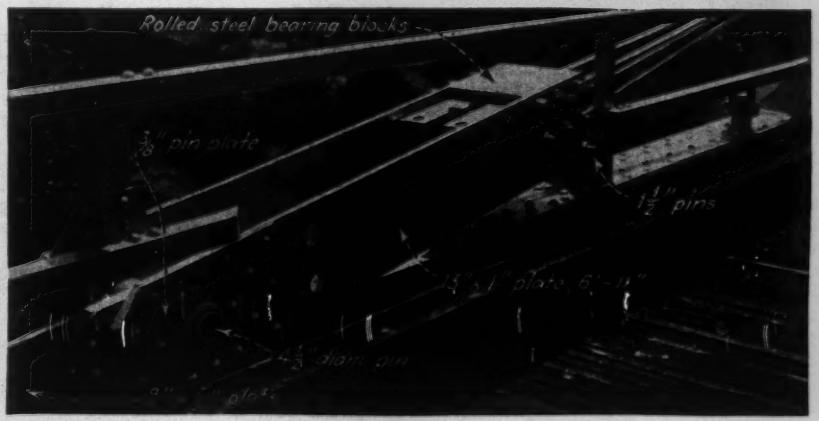
At the first panel point from the end of the side span the cable is below the top of the stiffening girder. Here the web of the stiffening girder was cut away and a casting, bearing on the web of the girder and on the pin connecting the eyeplates of the cable, was used to deliver the panel load to the cable. At the end of the side span the cable is connected to the stiffening girder by 4½-in.-diameter pins.

A complete design was made using 9-in. eyeplates throughout for the cable, but as near as could be determined by estimates there was practically no difference in the cost of the two cable designs. The strand cable required slightly more metal for the stiffening girders and a comparatively greater cost for the hanger connection to the cable. However, the strand cable required no falsework or temporary cables for erection and reduced to a minimum the number of pieces to handle in the shop and field.

Hangers consist of ¾-in. prestressed galvanized strands meeting the same requirements as specified for the main cable strands. They were fitted with open sockets at each end for attachment

Fig. 5—Cable clamp and hanger detail is novel and compact.





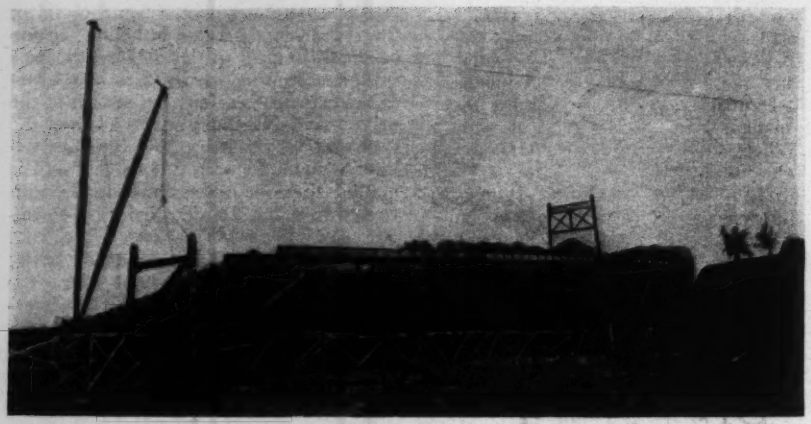


Fig. 6—Bridge superstructure, except cable system, was erected complete in one pass of a guy derrick.

to the girder and the cable. At the panel points near the center of the main span and at the splay point of the side span, built-up structural hangers were used.

The cable clamp consists of three sections of rolled-steel slab bored to receive the cable strands and bolted together with ⅞-in. turned bolts set vertically between the two tiers of strands. The interior of the strand groove was given a rough cut of sixteen tool marks per inch at right angles to the axes of the strands, to assist in developing the required friction. As shown by test, this roughened surface aided materially in increasing the frictional resistance of the clamp. The center section is bored horizontally, on the center line of the cable, to receive the pin which connects a yoke, made from a W.F. section. The web of this yoke is bored for connecting the hanger sockets.

Construction

All construction operations were carried on from the west bank of the lake. The first task to be performed was the driving of a falsework trestle, consisting of three-pile bents spaced to suit the superstructure erection scheme and capped at El. 670.5. From this trestle all substructure work was done, beginning at the east abutment and working toward the west end. Work began on the substructure Aug. 1, 1932, and was completed March 10, 1933.

For the superstructure erection a guy derrick with a 70-ft. boom was set up on the lower tier of falsework and began setting steel at the east abutment. Moving toward the west end, this derrick set all upper-tier falsework and all steel complete, including the towers, in one pass. All superstructure material was delivered to position by a cableway operating along the north side of the bridge. After all riveting was completed, the strands were hoisted into position and adjusted. After placing of the cable clamps and flooring, the hangers were connected by pulling the cable down by a ratchet device connected between a sling over the cable clamp and one underneath the stiffening girder. In order to prevent kinking of the cable, it was necessary to connect several of the hangers on each side simultaneously. Work on the superstructure was started Feb. 1 and was completed March 25, 1933.

Personnel

The bridge was built by the Missouri State Highway Department, of which T. H. Cutler is chief engineer and N. R. Sack bridge engineer. The design was prepared by the writer, who also acted as resident engineer.

The Clinton Bridge Works was the general contractor. The cable material was manufactured and prestressed by the American Steel and Wire Co. at its Trenton plant.

John Reese was foreman on the substructure work, and M. A. Nunnelly was foreman on the superstructure erection.

Tree and Crop Damage in Flood-Detention Basins

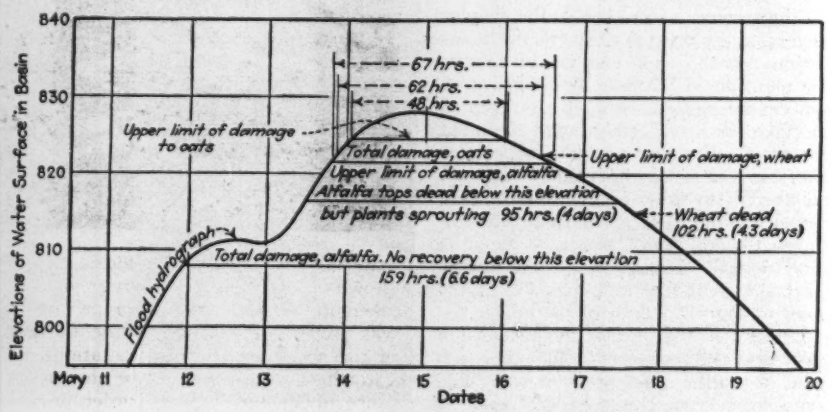
Data from May flood in Miami District basins show 2½ to 6½ days' submergence required to destroy grain crops

By C. H. Eiffert
Chief Engineer, Miami Conservancy District, Dayton, Ohio

THE RESERVOIRS or retarding basins of the Miami Conservancy District hold water only during floods, while the ordinary river flow passes through the dams without any retarding action. As most of the floods occur during the winter and early spring, it has been feasible to keep under cultivation practically all the farm land in the basins. Only twice in the twelve years since the completion of the dams have floods occurred in the growing season and damaged crops and trees. These floods came in June, 1924, and in May, 1933. Observations after the flood of last May give quantitative data on the amount of submergence required to destroy crops.

During and after the flood careful observations were made of tree and crop damage in the Englewood basin, where the highest backwater occurred. Trees were practically in full leaf at the time of the rise, and many of them were completely submerged for about one week. Ironwood seems to be the only variety in the affected area that was killed by the water, but as this is considered a weed tree by foresters its destruction is a benefit rather than a damage. A few individuals of other varieties were found to be apparently dead after the recession of the water, but most of them made a quick and complete recovery. The trees submerged were principally elm, cottonwood and willow; however, there were some of a number of other varieties common to this section of Ohio. The

Crops damaged by 2½ to 6½ days' submergence, as shown on May, 1933, flood hydrograph for Englewood retarding basin of Miami Conservancy District, Ohio.



leaves on the submerged trees were killed and dropped off, but new leaves came out immediately and in a short time the effect of the flood had completely vanished.

A number of fields of wheat, oats and alfalfa in the affected area extended from above flood level down to elevations at which they were submerged a sufficient length of time to kill the crops. By taking elevations below which crops were killed or damaged and comparing them with the flood hydrograph (gages are read every two hours), it was possible to determine the duration of submergence causing destruction or damage.

Damage to oats began with a 48-hour submergence and was total at 67 hours. Wheat damage began at 62 hours and was total at 102 hours, or 4.3 days. Alfalfa suffered temporary injury from submergence exceeding 4 days but recovered; with 6.6 days' submergence, however, it failed to recover.

Slide in Belle Fourche Dam Follows Reservoir Drawdown

Twenty-five-year-old irrigation dam in South Dakota damaged for a length of 600 ft.—Repairs require 20,000 cu.yd. of earth and replacement of 1,500 concrete paving blocks

AN EXTENSIVE SLIDE occurred in the upstream face of the earth dam that forms the Belle Fourche irrigation reservoir in South Dakota last summer when the reservoir was practically empty, following two abnormally dry seasons. The slide is believed to have been caused by the building up of hydrostatic pressure behind the concrete face of the upstream side.

Upstream face of the Belle Fourche Dam, showing the extent of the slide of Aug. 2, 1932. Before reconstruction was started, the reservoir was drawn down sufficiently to expose the entire area affected by the slide.

The Belle Fourche Dam was built during the period 1906 to 1909. It is a homogeneous embankment of heavy adobe clay 6,500 ft. long and having a maximum height of 115 ft. It was built without a corewall, the earth being distributed in 6-in. layers, watered and rolled. The upstream face, except for the portion above high water, has a slope of 2: 1 and is paved with concrete slabs laid upon a 24-in. layer of gravel. Last summer, during the drought period, the reservoir was drawn down to the lowest point ever reached, the rate of draw down amounting to 25 ft. in 60 days.

The major slide occurred on Aug. 2. It had a total length of 600 ft. with 20,000 cu.yd. of earth and 1,500 concrete paving blocks involved. Repair of the slide was undertaken immediately, using both the original material and gravel brought in and dumped within easy reach of the dragline excavators.

The method used in replacing the material affected by the slide is clearly shown in the accompanying picture, taken in October after the repair work was well under way. At the far end of the slide, where refill operations began, the material was wasted for a distance of about 100 ft. in order to provide space for beginning the refilling operations. From that point on the work progressed on a ramp with a slope of about 6 to 1.

Refilling the hole caused by the slide. At the left concrete blocks are being replaced upon the rebuilt fill.

A large dragline, not shown in the picture, supplied the gravel and other filling material to the caterpillar tractors used to haul it up the ramp for distribution and rolling.

As the new fill was brought up nearly to grade, a layer of gravel 2 ft. thick was put on to give a finished surface upon which to relay the concrete facing. Gravel for this purpose was delivered through chutes from the top of the dam.

The concrete paving immediately above the slide, which was not affected by the earth movement, was anchored in place by means of hooks and cables fastened to deadmen on the downstream side of the dam. This arrangement reduced the risk of possible injury to workmen from falling blocks, and also limited the area of paving affected by the slide.

An eave trough extending along the lower portion of the concrete unaffected by the slide was used to take care of rainwater coming down the face of the dam.

Concrete blocks loosened by the slide were removed by means of a dragline and caterpillar tractors, and were stored some distance from the work. After the slide had been refilled, the undamaged blocks were replaced, using a dragline excavator to set them. A slab of monolithic concrete was used to take the place of the blocks broken or destroyed. The new concrete amounted to about 5 per cent of the total area affected.

The operation of resetting the concrete blocks is shown in one of the accompanying illustrations, also the chutes from the crest of the dam for distributing gravel.

Last of Four Articles on the Design and Construction of Rolled-Earth Dams

New Principles Applied to Actual Dam-Building

Application of principles of soil compaction, as shown by several dams constructed, is entirely practicable and does not involve increased cost

By R. R. Proctor
Field Engineer, Bureau of Waterworks and Supply, Los Angeles, Calif.

THE DESIGN of an earthfill dam should be based on the findings of a thorough investigation of the watertightness and saturated stability of its foundation, particularly at the abutments, as well as a complete study of the characteristics of the soils that are available for its construction. The importance of watertightness in the abutments is often overlooked. Many engineers consider the water-percolation path under the maximum cross-section of the dam only, overlooking the possibility for water percolation from a point at the water surface near the top of the abutment and thence through the abutment to a point near the base of the dam. This path for percolation is often considerably shorter than that under the base of the dam, and particularly so if the abutments are steep. The available head is about the same—the depth of water in the reservoir. Considerable trouble with earth dams has resulted from the neglect of this point.

If the abutments of a dam cannot be established as sufficiently watertight, the cross-section should be increased at these points. This can be accomplished by extending the fill upstream from the dam along the abutment to such distance as may be required to establish a sufficiently long path of travel for percolating water in order to reduce its velocity to that which will be safe. The soil that is to be used for this portion of the dam requires more careful selection and construction than that in the dam proper; its thickness will be somewhat less than that in the main portion of the dam. The careful installation of such blankets or upstream extensions of the dam will be of great benefit at certain locations, and will usually be far more effective than the construction of concrete or other types of cutoff walls. A consideration of most cutoff-wall locations shows that the length of the percolation path through the foundation or abutment is increased by only a slight amount, not enough to be of material value.

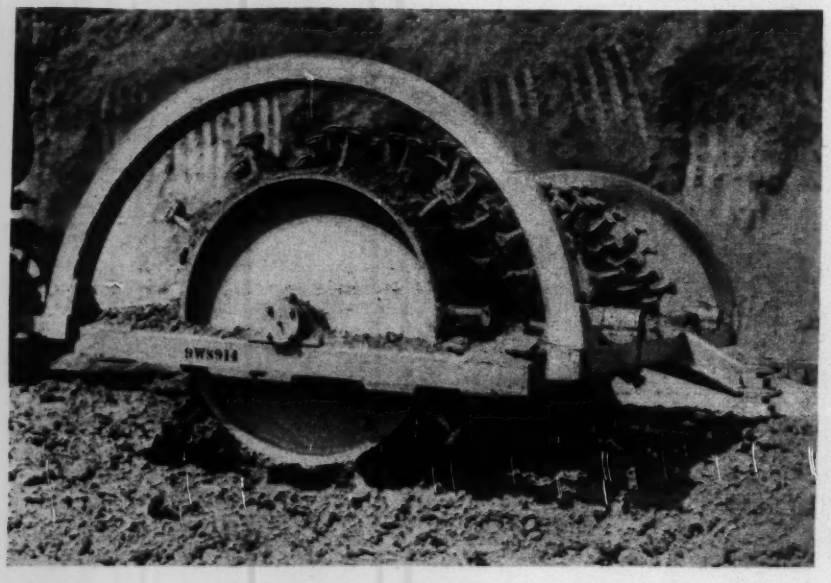


Fig. 1—Sheepsfoot roller of extra heavy design. The appearance of the surface of the soil and the penetration of the teeth should be as shown at the completion of the compacting process.

Cross-section

The cross-section of the main portion of the dam should be designed after careful consideration of its foundation. The data which have been secured from consolidation-percolation tests of properly compacted fills indicate that only a moderate cross-section is required if the foundation is on impervious rock. There is no doubt but that side slopes of 1 on 2 or less would have a considerable margin of safety if soils were available such as were used in the preparation of Fig. 7 (*ENR*, Sept. 7, 1933, p. 287), and were compacted to the dry weight at the peak of the curve.

The computed time required for the soil of the above figure to become saturated to a depth of 20 ft. under a head of 100 ft. of water is 2½ years. This saturation is accomplished by an increase in moisture content of 2½ per cent. The thickness required for watertightness under such conditions is not great. If the saturated and consolidated soil in this structure had a minimum plasticity-needle reading of 300 lb. per sq.in., 30 lb. being required to force a pencil into it, side slopes of 1 on 2 should provide ample security. If the dam is to be built upon a soil foundation of great depth, the cross-section should be much more liberal. Many such sites would probably require side slopes of at least 1 on 4 or more, to result in the same security as would be obtained by side slopes of 1 on 2 on a rock foundation. The cross-section of each dam, particularly if it is of great height, should therefore be very carefully selected after a thorough investigation of its foundation.

The usual custom of providing a porous section on the downstream side of an earthfill dam need not be followed. The practice in the past has been to place materials of doubtful watertightness on the downstream side of the dam to maintain its stability, in case percolating waters should cause the impervious upstream section to soften. Such materials usually are loosely placed and are supposed to pass water readily and not soften from saturation, thus lending support to the softened upstream section. This practice shortens the possible downward-percolation paths through the abutments that have been mentioned. It would be much better practice to design the compacted fill to accomplish the entire purpose of the dam than to depend on doubtful pervious material for stability. The entire purpose of the procedure that has been described is to insure the stability of compacted fills when saturated with water to the fullest extent. It is not necessary to provide drainage for such fills—in fact, it is better that they retain all of the water possible, to minimize shrinkage from drying.

The materials stripped from the

foundation and abutments that are unsuitable for use in the compacted fill may be placed on the downstream side of the dam, outside the cross-section that is required for watertightness and stability. This is probably the cheapest place at which they may be wasted. They should be useful for such purposes as terracing, landscaping and providing roadways. When so placed, the waste materials can provide a loose-soil cover to prevent excessive drying of the compacted fill if the water surface in the reservoir is to be low for long periods, or if the percolation rate of the compacted fill is less than the evaporation rate from the soil surface.

Upstream slope

The protection of the slope of the dam from erosion by the water in the reservoir is very important. This may be accomplished by a properly designed concrete facing or by a rock riprap of sufficient depth. The choice of method should be governed by cost. The required depth of riprap can be determined only from consideration of the size of the reservoir and the nature of the available rock. A concrete facing of 6-in. thickness should be ample for any exposure. If made of plain concrete, there is danger that shrinkage cracks will develop with sufficient opening to permit a slow undercutting of the slab by wave action. It is best to provide steel reinforcement of the slab in sufficient quantity so that its tensile strength, without permanent elongation, is in excess of the tensile strength of the concrete, in any direction. This will not prevent shrinkage cracks, but will insure against any opening more than about 0.02 in. A concrete slab of this design is proof against undercutting by wave action. The absence of large unsightly cracks greatly improves the appearance of the structure and adds much to the layman's impression of the security of the dam. A specimen of such a concrete slab, 20 ft. in length, was stretched 6 in. before final failure at one of fifteen cracks that had opened. A slab of such flexibility, probably not adding to the watertightness of the dam in normal use, should prove of great benefit in checking a large flow of water that might take place in case of a seismic disturbance of sufficient intensity to open cracks through the dam. The ends of the slab should be anchored to a wall of such dimensions that it will not be moved by the stresses in the slab and so located that it will not be exposed to undermining by wave action.

Selection of soils

The selection of the soils that are to be used in the compacted fill should be governed by the cost of their use as well as their suitability. It is unnecessary to select those of high clay content—in fact, this should not be done. The cost of handling such soils is

Fig. 2—Measurement of plasticity-needle penetration resistance and dry weight of test fill compacted to determine required number of trips and weight of sheepsfoot-type rollers for the construction of Bouquet Dam No. 1.

slightly higher than in the case of a lower clay content. The soils that are available in the best quantity and location for economical construction should be selected, if the compaction-consolidation-percolation tests indicate them to be suitable. Soils that will be found unsuitable are not numerous, and the methods that have been outlined permit the use of most natural soils, including some that appear to be streambed gravels. Soils that are poorly graded and almost wholly lacking in fine particles cannot, of course, be used.

The examination of proposed borrowpits is best made by the use of auger holes that must be so spaced as to insure samples from all types of soil that will be encountered. Representative samples of all the various types of samples secured should be selected and the complete soil-characteristic curves, such as Fig. 7 in the issue of Sept. 7, p. 287, should be obtained for each. A study of these curves indicates any necessity for further testing of this kind. If there is a wide variation in the required moisture contents for plasticity-needle readings of some intermediate value, such as 500 lb. per sq.in. in the compacted soil, sufficient additional samples should be tested so that all different types of soil will be discovered. The most porous or sandy-appearing samples should then be selected for consolidation-percolation tests. If the tests on these are satisfactory, it will not be necessary to conduct a large number of these tests on the other soils, as they can be established as satisfactory with a few tests.

When the possible borrowpits have been explored in this way the soils for use can be selected. The selection of those that are most uniform throughout the depth of the proposed cut will lower the construction costs. They may be more accurately moistened in the pit, thus requiring a minimum of moistening on the dam. The output of the construction equipment will be more uniform, resulting in greater production from a particular construction plant. If the volume of the dam is large in comparison with the volume of the reservoir, careful consideration should be given to borrowpits that are within the operating storage level. A computation of the contemplated expenditure for a cubic yard of water storage may show credit for increased storage, which will justify a slightly higher construction expense to obtain soils from within the reservoir at a point that does not affect the watertightness of the dam.

Rolling equipment

The selection of the type of construction equipment should be made after the desired density of the compacted fill has been determined. Rollers of the sheepsfoot type, shown in Fig. 1, are far superior to the flat-wheel roller. The pressure on the teeth of the sheepsfoot roller can be adjusted to give any desired degree of compaction. The efficiency of modern tractors has made possible the economic use of compacting equipment of two or three times the weight that has previously been used.

Fig. 3—Sampling of proposed borrowpit for Bouquet Dam No. 1.

Fig. 4—Placing of 6-in. reinforced-concrete slab to protect the compacted fill from wave action at Chatsworth Dam No. 2.

Pressures as high as 200 lb. per sq.in. may be obtained easily with a final penetration of 3 in. by the teeth of the roller. The action of widely spaced teeth on these rollers gives a kneading action in the soil that is necessary to force the various sizes of soil particles into the proper relation to obtain the required soil density.

Sheepsfoot rollers of the type usually manufactured are sufficiently heavy for soils that are to be compacted to a plasticity-needle reading of 200 to 400 lb. Where higher plasticity-needle readings are required, the weight of the roller must be increased in approximately the same ratio as the increase in plasticity-needle reading. The teeth on most sheepsfoot rollers available are closely spaced, but wider spacing is preferable for efficient compacting, as the soil is thereby given more of the required kneading action.

Preparation of soils

The soils in the proposed borrowpits should receive their proper moisture content well in advance of the time that they are to be placed on the dam. The proper moisture content can be determined from the soil characteristic curves, similar to Fig. 7 in our issue of Sept. 7, p. 287. The desired moisture content for each type of soil below a given point in the borrowpit can be determined in this way. The difference between this moisture content and that which is in the soil makes possible a computation of the quantity of water that must be added. The soil may be sampled for the purpose of checking this addition of water with a standard 1-in. soil sampler or by an auger hole. The auger hole is preferable, as it furnishes sufficient soil to prepare a composite sample for a determination of the soil-characteristic curves, if desired. A second computation of the required moisture to be added may be made after this sampling and should result in the proper soil-moisture content. The soil should arrive at the dam with the proper moisture content for the conditions of minimum evaporation. It is necessary to add moisture on the dam to correct for the conditions of higher evaporation.

The moisture content of the soil may be checked by use of the compaction cylinder and plasticity needle when it arrives at the dam. The inspector can then direct the addition of such water as may be required as the soil is being leveled in preparation for compaction. The moisture content should again be checked before the compacting process is started. The number of trips of a sheepsfoot roller required to compact a soil properly is very important. Extensive experiments have indicated that a minimum of 16 and as high as 25 are required, depending on the requirements for the soil density. It is very important that this work be carried on in a systematic manner. When the required number of trips has been made, the inspector should check the completeness of the compaction with the compaction cylinder and plasticity needle, as has been outlined. If the plasticity-needle reading in the fill is as much as 25 per cent lower than that in the compaction cylinder, more trips of the rollers should be required, or the dry weight in place should be determined to establish definitely the thoroughness of compaction. The inspector should be particularly alert to discover any lack of overlapping in the travel of the rollers.

Testing the compacted soil

The dry weight in place of the compacted soil should usually be determined at least once for every 1,000 cu.yd. placed on the dam. The results obtained from this test furnish a basis for keeping the inspectors informed as to the plasticity-needle requirements for the control of the moisture content and compaction of the soil. They also furnish a basis for determining the number of trips which the rollers must make in order to compact the soil to the required dry weight. The number of trips of the rollers should be determiner from the results of the dry-weight tests of the soil after it is placed in the dam.

Consolidation and percolation tests should be made at such intervals as are required to control the construction operations and to furnish sufficient records of the quality of the work performed. These should be kept with the same regard for future records as is done in the best concrete-placing practice. A close study of the results of these tests furnishes the engineer with a final check on the watertightness and stability of the structure. The construction methods can be varied, as the work progresses, to remedy any deficiencies found by the tests or to effect economies in the construction cost when it is established that the safety of the structure will not be affected.

Application to construction

Dam No. 1 of the Bouquet Canyon project is now being built by the construction forces of the Bureau of Water Works and Supply of the city of Los Angeles. The methods of construction control that have just been described are now in use on this project. The dam is to be 221 ft. high when completed, with a crest width of 50 ft. and side slopes of 3 to 1. The upstream two-thirds of the cross-section requires about 2,000,000 cu.yd. of compacted earthfill, and the downstream third requires 700,000 cu.yd. of more pervious fill, most of which is obtained from stripping operations. The entire foundation for the compacted fill is stripped to firm bedrock; dry-weight tests of the natural soils in place determined that they should be removed and compacted to a higher dry weight. They were therefore removed and compacted in other portions of the dam.

The available soils for the compacted section of the dam were explored with a 16-in. power auger, shown in Fig. 3. The auger holes were spaced about 200 ft. apart, varying in depth from 10 to 50 ft. A composite sample of each 5-ft. depth of hole was secured and removed to the laboratory. Soil-characteristic curves, similar to Fig. 7 (*ENR*, Sept. 7, 1933, p. 287, were prepared for 145 representative soil samples secured from 109 auger holes. The mean percolation rate for 40 samples tested was 0.04 ft. per year. The most economical location of the borrowpit was then selected, considering the value of the 1,250 additional acre-ft. of storage within the operating levels of the reservoir and the cost of truck haul. A minimum plasticity-needle penetration

resistance (when saturated) of 300 lb. per sq.in. was established, and the percolation rate limited to 0.30 ft. per year.

A test was then made of the compaction results that could be secured with the available sheepsfoot rollers (see Fig. 2, Aug. 31, p. 246). Tests were also made to determine the compacting effect of 10 to 30 trips of the rollers, resulting in the selection of a minimum of sixteen trips. The rollers were found to be too light to accomplish the desired degree of compaction, so that rollers were then designed (Fig. 1) having a weight of about 8,000 lb. on a single drum. The effect of this change is shown in Fig. 7 of the issue of Sept. 7, p. 287.

The moisture contents of the first soils to be used were determined by sampling with 1-in. sampler tubes two months before the start of the work. The required quantity of water was added and checked, resulting in the correct soil-moisture content for proper compaction. Additional samples were taken from the borrowpit as the various soils were uncovered, so that soil-characteristic curves and consolidation-percolation results would be available at least two weeks before the soil was to be used. Sixty of these tests disclosed some 5 ft. of depth samples that had percolation rates above the maximum. Composite samples for a 20-ft. depth of these holes were then tested, resulting in percolation rates well below the maximum. The operation of the construction equipment was found thoroughly

Fig. 5—Chatsworth Dam No. 2, raised and enlarged in connection with the increase of storage facilities of the Bureau of Waterworks and Supply of the city of Los Angles. The extension of the dam along the right abutment to lengthen the path of percolation through it appears in the foreground.

to mix the soils from a 20-ft. bank in all cases. A small amount of extremely sandy soil was diverted to the porous fill for two days, until consolidation-percolation tests had determined it to be satisfactory. The consolidation-percolation tests of the compacted fill have disclosed no percolation rates above the established maximum.

Twenty trips of the rollers were used to compact the first 500,000 cu.yd. of fill, and the number of trips was then reduced to sixteen without an appreciable effect on the compaction results. A compacted plasticity-needle penetration resistance of about 900 lb. per sq. in. has been found most economical of construction, resulting in a fill with an average penetration resistance well over the minimum established. Small quantities of the compacted soil have a penetration resistance as low as 400 lb. per sq.in. The maximum allowable penetration resistance is 2,000 lb. per sq.in. Lower moisture contents than required for this value are liable to result in an undesirably smooth surface after the soil is compacted. The required surface after compaction for proper bond between soil layers is shown in Fig. 1. The dry-weight tests of the compacted soil have disclosed a few cases where additional compacting was required. The dry weight has been raised to the desired value after making additional trips of the rollers. Each area of low dry weight is tested after rerolling.

The compacted fill is being placed at a monthly average of 9,000 cu.yd. per day with two shifts. There are six in-

SUMMARY OF FIELD AND LABORATORY TESTS OF COMPACT FILL

Date and Identification Number	Fill Conditions: At Fill Moisture: Dry Weight, Lb. Fill	Dry Weight, Lb. Compaction Cylinder	Plasticity Needle (Lb./Sq.In.) Fill	Plasticity Needle (Lb./Sq.In.) Compaction Cylinder	Moisture Content, Per Cent	At Fill Dry Wgt. (Saturated): Moisture Content, Per Cent	Indicated Plasticity Needle Lb. Per Sq. In.	Laboratory Conditions: Characteristics At Maximum Dry Wgt.: Dry Weight, Lb.	Moisture Content, Per Cent	Plasticity Needle, Lb. Per Sq. In	Specific Gravity	Consolidation-Percolation Results: Dry Weight as Placed, Lb.	Applied Pressure Equivalent, Ft. of Fill	Resulting Dry Weight, Lb.	At Removal: Plasticity Needle, Lb. Per Sq. In.	At Removal: Moisture Content, Per Cent	Final Percolation Rate, Ft. Per Year	Remarks
1-9-33 A	126.0	125.0	690	950	13.0	....	....	....	....	....	....	....	....	....	....	....	....	100′ So. of Sta. 5+75 El. 2864
1-9-33 B	122.0	124.0	950	975	13.0	....	....	....	....	....	....	....	....	....	....	....	....	520′ No. of Sta. 7+75 El. 2837
1-9-33 X	121.0	125.0	725	950	13.0	....	....	....	....	....	....	....	....	....	....	....	....	200′ No. of Sta. 7+10 El. 2851
1-10-33 A	127.0	123.0	550	750	14.0	....	....	....	....	....	....	....	....	....	....	....	....	50′ No. of Sta. 6+65 El. 2862
1-10-33A*	128.2	123.3	550	900	13.2	12.5	1,400	124.1	12.0	2,000	2.77	....	....	....	....	....	....	60′ No. of Sta. 6+65 El. 2862
1-10-33B	122.0	125.0	1,150	1,300	13.0	....	....	....	....	....	....	....	....	....	....	....	....	150′ No. of Sta. 8+50 El. 2858
1-10-33B*	123.7	124.4	1,125	1,500	11.7	14.5	300	124.3	11.5	1,500	2.78	122.0	100	127.8	1,800	13.3	0.0082	150′ No. of Sta. 8+50 El. 2858
1-10-33X	121.7	124.8	775	900	13.3	....	....	....	....	....	....	....	....	....	....	....	....	460′ No of Sta. 10+00 El. 2826
1-12-33A	128.0	126.0	1,100	1,600	12.0	....	....	....	....	....	....	....	....	....	....	....	....	300′ No. of Sta. 7+25 El. 2853
1-12-33A*	129.8	124.5	1,100	1,475	11.4	12.0	1,000	124.4	11.5	1,400	2.78	124.1	65	126.9	1,500	13.4	0.145	300′ No. of Sta. 7+25 El. 2853
1-12-33B	125.0	126.0	1,225	1,500	12.0	....	....	....	....	....	....	....	....	....	....	....	....	450′ No. of Sta. 8+00 El. 2846
1-12-33B*	125.8	126.7	1,350	2,000	11.2	13.6	800	126.5	11.4	2,000	2.76	....	....	....	....	....	....	450′ No. of Sta. 8+00 El. 2846
1-12-33X	122.0	124.8	1,325	950	13.0	....	....	....	....	....	....	....	....	....	....	....	....	510′ No. of Sta. 6+50 El. 2840
1-12-33Y	126.0	125.8	1,500	1,700	12.0	....	....	....	....	....	....	....	....	....	....	....	....	100 No. of Sta. 9+50 El. 2837
1-13-33A	123.0	126.0	975	1,500	12.0	....	....	....	....	....	....	....	....	....	....	....	....	410′ No. of Sta. 10+30 El. 2825
1-13-33B	127.0	128.0	1,480	2,000	11.0	....	....	....	....	....	....	....	....	....	....	....	....	40′ No. of Sta. 7+70 El. 2866
1-13-33X	126.0	123.0	1,325	1,900	12.0	....	....	....	....	....	....	....	....	....	....	....	....	350′ No. of Sta. 6+40
1-13-33Y	126.0	121.0	950	1,000	13.0	....	....	....	....	....	....	....	....	....	....	....	....	510′ No. of Sta. 7+95 El. 2840

*Check of field measurements by laboratory forces.

spectors of this operation at the work; one is in charge, one supervises the moistening of the borrowpit, and two are employed on the dam for each shift, supervising the moistening of the soil on the dam when required, testing the compaction of the soil with the plasticity needle and making dry-weight measurements of the compacted soil in place, following the methods that have been outlined. Two men are used continuously in the laboratory to prepare soil-characteristic curves and conduct consolidation-percolation tests of borrowpit samples sent from the field. This laboratory personnel also performs about four dry-weight tests of the compacted fill per week, thus insuring a uniformity of method in the laboratory and field. Soil-characteristic curves are prepared for the compacted-soil samples, and consolidation-percolation tests are made of the soil when placed in the apparatus at the compacted dry weight. These data furnish the field force with complete information to plan changes in method that may be required from time to time to secure the required results. Fifty consecutive consolidation-percolation tests, covering the placing of 700,000 cu.yd. of fill and duplicating field conditions, had an average percolation rate of 0.0136 ft. per year; the maximum rate was 0.1450 ft. per year, and the minimum was 0.0014 ft. per year. The minimum plasticity-needle penetration resistance upon completion of the test was 400 lb. per sq.in., resulting from consolidation under a load equivalent to 5 ft. of fill. The maximum penetration resistance was 2,000 lb. per sq.in., resulting from consolidation under a load equivalent to 150 ft. of fill. A summary of eighteen field and laboratory tests of the compacted soil at Bouquet Dam No. 1 is shown in the table. It is especially interesting to note the close agreement between the compacted dry weights in the fill and in the compaction cylinder.

The careful use of the methods that have been described furnishes a very close control over the soil-placing operations. The tests can be carried to any desired extent of thoroughness and do not involve any great item of expense. When proper engineering supervision over the entire excavating and compacting process is exercised, the output from a group of men and equipment is increased. When the soil in the borrowpit is properly moistened, the excavation equipment has a uniform output through the day, and there are no delays caused by avoiding areas that are too dry or are unexpectedly pronounced unsuitable by the engineer. A steady output at the borrowpits makes possible the efficient use of hauling, placing and compacting equipment. An efficient inspection organization can easily effect savings in construction costs that are several times the cost of the entire inspection and testing. The final result of such supervision should be a dam with a predetermined degree of watertightness and stability.

This procedure is, as far as the writer is informed, new to the engineering profession. It has been developed in the past three years during the construction of the Chatsworth No. 2 and No. 3, Upper Hollywood and Bouquet No. 1 dams. An extensive program of careful laboratory investigation has been undertaken and considerable effort expended to make the new ideas that have been developed thoroughly practical in their application to the work. The methods may appear rather complicated, but it must be remembered that soils are probably the most widely variable construction material with which the engineer has to deal. It is hoped that this discussion will clear up many of the uncertainties of earth-dam construction in particular and soil compaction in general that have been very difficult to overcome in the past.

Acknowledgments

The methods of procedure that have been outlined were developed in the laboratory and field by the field engineering division of the Bureau of Water Works and Supply of the city of Los Angeles, of which H. A. Van Norman is chief engineer and general manager and W. W. Hurlbut is engineer of waterworks. The late Lester L. Meyer was assistant field engineer and contributed greatly to all phases of the development of the procedure. N. M. Imbertson, H. B. Hemborg and N. F. Crossley have acted as resident engineers on the various projects and have contributed to the efficient field application of the methods. R. O. Ridenour has contributed to the design of the various equipment, and S. E. Smith directed most of the laboratory work.

Excavating Close to Building Without Underpinning

Deep sewage regulator alongside shallow foundation constructed in sections to avoid underpinning—Regulator wall buttressed to serve as maintaining wall

By W. Ogden Johnson
Chief Engineer, Hewitt Construction Corp., New York, N. Y.

AN UNUSUAL METHOD of supporting a shallow foundation was devised during the construction of the South Yonkers (N. Y.) intercepting sewer, recently completed by the Westchester County Sanitary Sewer Commission. The construction of a sewage regulator required the excavation of a chamber approximately 18 ft. deep located about 8 ft. from a six-story apartment house. A test pit dug to explore the existing foundations revealed that the exterior wall of the building was based on a very poor rubble masonry footing resting on loose sand and small boulders at a depth of 3 ft.

Three methods of handling the problem were considered. First, the conventional method of underpinning the wall by successive pits excavated to safe slope and concreted to form piers was studied but rejected. The character of the ground and the suspected presence of water at lower elevations indicated the loss of some ground in the construction of the pits, with consequent damage, certainly to the basement floor and possibly to the exterior wall itself. Second, the construction of a retaining wall of gravity type was considered, to be built in successive pits and forming a part of the walls of the proposed structure. This had the advantage of maintaining the building without disturbing the original ground directly beneath it, but was rejected chiefly on account of the resulting cost of such a volume of excess excavation and concrete as would be required for a gravity section. The third method consisted of redesigning the lower portion of the proposed structure to act as a maintaining wall, the structure being built in successive pits of comparatively large size. This method, which was accepted by the commission, had the advantages of safety, minimum excavation and practically no increase in concrete over the original design.

Fig. 1 shows a general plan and typical sections of the regulating chamber in relation to the apartment house. The complicated floor and lower-wall sections are required primarily to form channels for the flow of sewage in the regulating mechanism and have been skillfully adapted to form buttresses restraining the side of the excavation next to the building.

The method of procedure was as follows: Vertical sheeting was placed to a depth of about 8 ft., which was above the safe slope assumed from the building footing. To make sure of the safe-slope assumption, a thin neat cement grout was pumped in behind the lower third of the sheeting, filling the voids and partly cementing the loose porous sand, gravel and small boulders encountered. A pit (Fig. 1) was then sunk to subgrade, using 3-in. horizontal pit boards, widely spaced to permit packing with sand behind the boards. The

size of this pit, about 6x9½ ft., required a center brace on the 9-ft. side, which was installed in sections as the pit was advanced and was replaced by a box frame when subgrade was reached.

A large flow of groundwater was encountered about 7 ft. above subgrade, which proved troublesome to handle. Night pumping was prohibited due to the residential character of the neighborhood, and rapid lowering of the water level by pumping from a sump caused a dangerous loss of ground. A well-point system was installed, using points closely spaced. Sufficient points were put down throughout the entire area covered by the chamber to lower the water level in a single pit to subgrade in three to four hours. The pit was then carried somewhat below subgrade, and a bed of broken stone was laid down, after which the well points were shut off in succession, allowing the water to rise and slowly flooding the pit for the night. A second dewatering permitted the placing of the bottom concrete, the points being boxed through the concrete and remaining a part of the drainage system for the successive pits. As sections of the bottom and walls were poured within the limits of a pit, the reinforcing rod splices were bent up against the sides of the pit to be straightened out into the next succeeding one.

After concreting pit 1, excavation and concreting in pit 2 were undertaken, followed by pits 3 and 4. Fig. 2 shows the water-level being lowered in the first two completed pits, while excavation is in progress in the next pit. When the first four pits were completed, the well points were withdrawn and the resulting holes in the floor plugged with concrete. Bleeder pipes in the plugs were grouted to seal the bottom, and other grout pipes in the walls adjacent to the building were grouted to fill any voids left behind the pit boards. The portions of the structure acting as a maintaining wall for the building were complete when pit 4 was concreted. There remained only the fluming of the existing sewer and the construction of pits 5 and 6 to finish the lower portions of the regulator chamber. At this stage these pits drained down into the preceding ones, which acted as a sump. Completing the upper walls and roof presented no particular problem.

Throughout the work, daily elevations were taken on the building. These showed no movement, nor were any cracks, indicating even minute settlement, observed during or after construction.

The work was carried on under the direction of W. W. Young, consulting engineer of the Westchester County Sanitary Sewer Commission, and J. W. Van Denburg, project engineer. The method was devised by the writer who was in charge of the contract held by Hewitt Construction Corp..

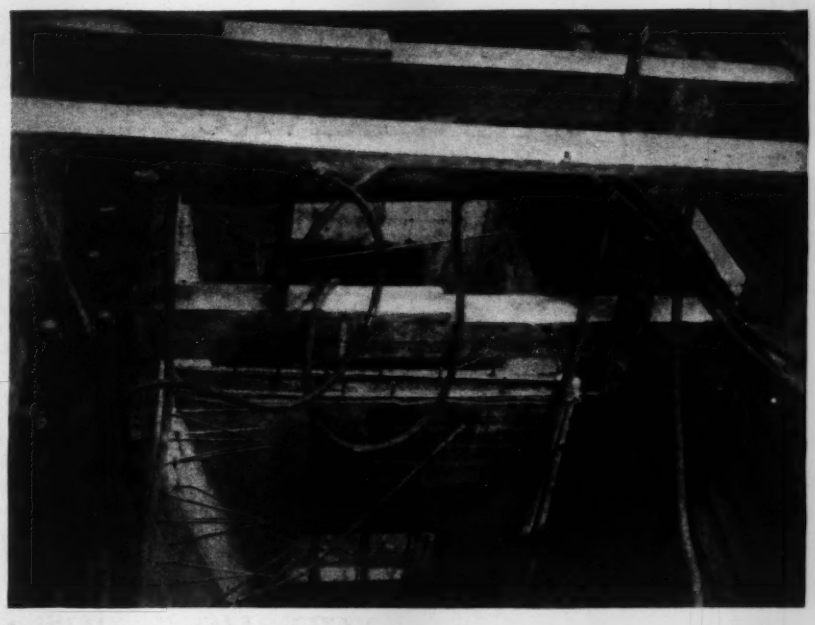


Fig. 2—Water level being lowered in completed pits 1 and 2, showing buttress effect of concrete construction, well-point header and rod splices. The left-hand side is adjacent to the building.

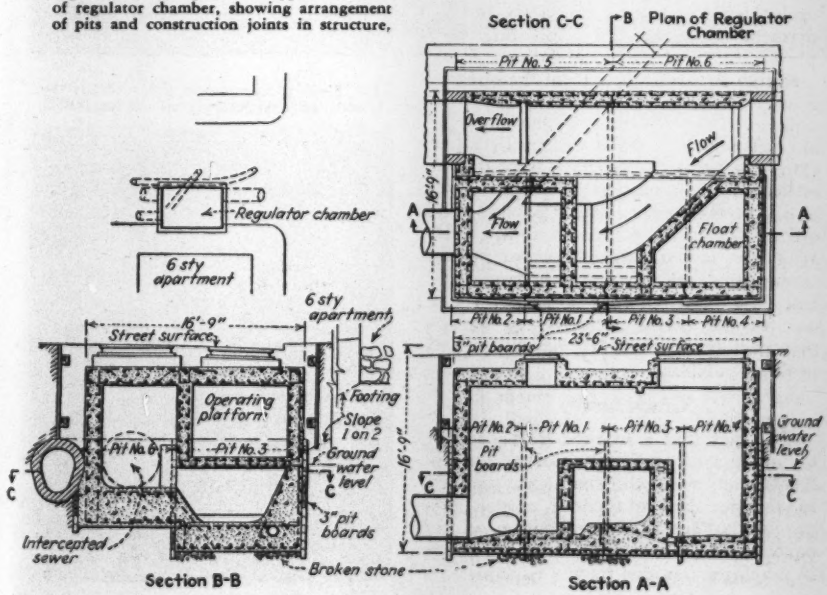


Fig. 1—Location plan and typical sections of regulator chamber, showing arrangement of pits and construction joints in structure.

Singapore Tests Rubber Pipe In Sea Water

Indication of the ability of rubber pipe to withstand immersion in seawater is contained in the 1932 annual report of the water department of Singapore, Straits Settlements. The report includes a discussion of some experiments made with a 12-ft. length of 4-in. internal diameter armored rubber pipe connected to the town's water supply and immersed in the sea. Service conditions involved an internal working pressure of about 45 lb. per sq.in. The rubber pipe was first immersed on Dec. 24, 1930, and when last inspected on Oct. 18, 1932, was found to be in excellent condition. It was then tested to 100 lb. per sq.in. without any sign of leakage or failure. The supply pipe connecting this length of rubber pipe with the rest of the distribution system has frequently failed through the corrosive action of the seawater. Various types of metal connecting pipes have been experimented with but none of them has survived the conditions mentioned for more than four months. According to the report, the investigation was inspired by an account of the installation of a submerged water main of reinforced rubber pipe by W. C. Munroe, ENR, May 22, 1930.

Old Ohio Concrete Road Shows Record Service

Crack-and-strength survey of road slab laid in 1914-15 reveals remarkable condition of concrete—Reconstruction made necessary only by narrow width

By F. H. Jackson
Senior Engineer of Tests, Bureau of Public Roads, Washington, D. C.

IN 1914-15 a section of the National Old Trails Road, now known as U. S. Route 40 was improved by a concrete pavement extending from Zanesville, Ohio, west about 24 miles. The present condition of this road illustrates the possibility of constructing a high-type road surface that will adequately serve heavy traffic for nearly twenty years with substantially no replacements and with only the usual maintenance.

Construction

The road was constructed jointly by the U. S. Bureau of Public Roads and the state of Ohio, under the old Post Road Act, two years prior to the passage of the first federal-aid highway act in 1916. Although only 16 ft. wide and 6 in. thick at the edges, this pavement has outlived many concrete roads built since 1914, a result due largely in the writer's opinion to the excellent quality of the concrete used in its construction. If it were not for the fact that the pavement was designed in accordance with 1914 standards of width, cross-section and alignment, and is consequently from this standpoint entirely inadequate to serve the needs of present-day traffic, it would probably not be necessary to reconstruct it for many years. Inadequate width and poor alignment have, however, necessitated improvements which are now being made and which include widening to 24 ft., resurfacing and relocation at many points in order to eliminate bad curves.

Fig. 1—Excellent quality of concrete shown by narrow slab formed by longitudinal crack and pavement edge.

The portion of the road in Licking County was constructed with crushed limestone as coarse aggregate, using a 1:1¼:3 mix, damp, loose volume, whereas that portion lying in Muskingum County was constructed with gravel as coarse aggregate, using a 1:1½:3 mix. The same cement and sand were used throughout. The materials were all of good quality. Much more attention was paid, also, to the matter of consistency than was usual at that time. This great care has been more than justified by the excellent quality of the concrete, which has been under traffic for nearly twenty years without showing any evidence of surface scaling, weathering or disintegration. Most of the failures that have occurred, other than structural cracks, have been due to settlement, a condition which in some localities has necessitated patching in order to bring the pavement up to grade. However, it is of interest to note in this connection that the crack survey made last year revealed that less than 1 per cent of the entire surface area in approximately 20 miles of pavement had been so patched.

Crack survey

The fact that a marked difference in the amount of cracking observed on different sections of the road corresponded to changes in the type of coarse aggregate has led to an assumption on the part of observers that the difference in cracking was due to this variable. To throw light on this subject, a crack survey of two 1-mile sections of the road was made in 1924 when the road was ten years old. The results of this crack survey were published at the time (See "Condition of the Ohio Post Road After Ten Years Under Traffic," *Public Roads*, Vol. 6, No. 4, June, 1925) and indicated a marked difference in the amount of cracking on the two sections. Due to the fact that the road was to be widened and resurfaced and that consequently any further observations would be impossible, it was decided in 1932 to make another survey to determine the amount of cracking which had taken place up to that time.

This survey covered 19.8 miles of the 24-mile section and was made by counting the number of 30-ft. slabs showing various amounts of transverse and longitudinal cracking. The count was made by observers in an automobile traveling along the edge of the road at approximately 10 miles per hour and of course is only approximate. However it is believed sufficiently accurate to give a fairly true picture of the amount of cracking that has developed.

Samples of the concrete were also obtained for both compression and flexure

Fig. 2—Small triangular slabs formed by intersecting cracks remain intact.

Fig. 3—Edge of concrete slab virtually unbroken after eighteen years under traffic.

tests. Tests for compression were made on cores drilled from the roadway. Tests for flexure were made on beams cut from large slabs approximately 6 ft. square which were removed from the pavement by means of jack hammers.

Figs. 1, 2 and 3 are details illustrating the excellent condition of the concrete. Note that in spite of the longitudinal edge crack shown in Fig. 1 the concrete is still intact. The ability of small triangular slabs to withstand the action of traffic is illustrated in Fig. 2. Both of these conditions are typical as is also the excellent condition of the edge of the slab as shown in Fig. 3. The condition of many small slabs formed by the intersection of structural cracks illustrates to a marked degree the character of the concrete. The cross-section design, 6-in. edge thickness, could not prevent the formation of these cracks. The quality of the concrete, however, was such that even the small slabs failed to break up under traffic, which would have been the case had the concrete been of inferior quality. Due to this, the replacement cost was held to a minimum and the necessity for reconstruction was delayed many years.

The results of the crack survey are shown graphically in Fig. 4. In this chart the percentage of slabs having the indicated number of either transverse or longitudinal cracks is shown for each coarse aggregate type. This chart reveals a number of interesting relationships. In the first place it will be noted that 7 per cent of all of the 30-ft. slabs containing gravel and 33 per cent of all the 30-ft. slabs containing limestone were free from transverse cracks. This shows not only that a substantial proportion of the total number of slabs was uncracked after eighteen years' service, but also denotes a tendency for the gravel concrete to crack more than the slabs containing crushed stone. The survey also indicates that in both cases 60 per cent of the total number of slabs contained one transverse crack, with 22 per cent of the gravel concrete sections showing two transverse cracks as compared to 5 per cent for the stone concrete. The excellent quality of the concrete is attested by the fact that only 10 per cent of the total number of slabs in 20 miles of pavement contained three or more transverse cracks. The distribution of longitudinal cracking is of the same order in so far as type of aggregate is concerned, although the differences are not so marked. It is of interest to note that roughly 50 per cent of the entire pavement was entirely free from longitudinal cracks and only a very small percentage (less than 10 per cent) contained more than one longitudinal crack.

Fig. 4—Chart of amount of cracking of two kinds of concrete after eighteen years' service in Ohio concrete road.

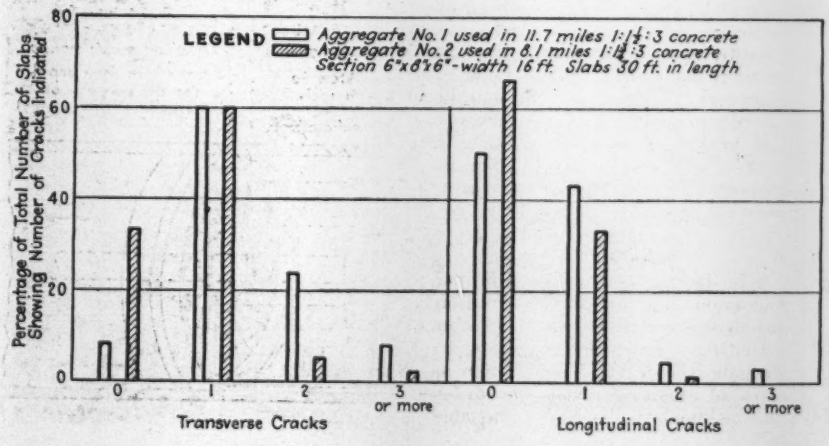


TABLE I—CRUSHING STRENGTHS OF CONCRETE CORES FROM OHIO POST ROAD

Specimen No.	Gravel Concrete		Crushed-Stone Concrete	
	Height of Core, In.	Crushing Strength Lb. Per Sq. In.	Height of Core, In.	Crushing Strength Lb. Per Sq. In.
1	7.5	7,400	7.8	6,280
2	6.9	7,560	7.4	7,790
3	7.5	5,920	6.6	6,160
4	8.3	7,330	7.5	6,190
5	7.0	5,920	.....	.....
6	7.4	5,880	.....	.....
7	6.4	6,440	.....	.....
8	7.2	6,040	.....	.....
Average	.....	6,560	.....	6,605

Strengths corrected to give equivalent values for a ratio of height to diameters of 2. All cores stored in water for three days just prior to testing.

TABLE II—FLEXURAL STRENGTH OF BEAMS SAWED FROM CONCRETE SLABS TAKEN FROM THE OHIO POST ROAD

Beam No.	Gravel Concrete			Crushed-Stone Concrete		
	Modulus of Rupture			Modulus of Rupture		
	First Break Lb./Sq. In.	Second Break Lb./Sq. In.	Average Lb./Sq. In.	First Break Lb./Sq. In.	Second Break Lb./Sq. In.	Average
1	1,140	1,122	1,131	1,108	965	1,036
2	1,210	1,050	1,130	1,063	1,074	1,068
3	1,221	1,092	1,156	956	1,024	990
4	1,046	1,294	1,170	.....	.....	.....
Average	.....	.....	1,147	.....	.....	1,032

All beams stored in water 48 hours just prior to test. Beams tested with side (sawed surface) in tension. Width 7 in., depth 6 in., loaded at center of 18-in. span.

Strength tests

It will be of interest to note the strength attained by this concrete. As previously indicated a number of cores were drilled from the pavement in 1932. These cores were obtained at widely scattered points along the road. The results of compression tests made by the bureau at Washington are shown in Table I.

The crushing strength varied from 5,880 to 7,790 lb. per sq.in. The average strength is somewhat more than double the strength developed by molded cylinders at the age of 28 days. The two types of aggregate give about the same results, the average of the four crushed stone cores being 6,605 lb. per sq.in. and the average for the eight gravel cores 6,560 lb. per sq.in.

In Table II are shown the corresponding results of the flexure tests. It will be observed that the gravel concrete gives values somewhat higher than the crushed-stone concrete. The results in both cases are high and indicate again the excellent quality of the concrete.

In view of the difference in cracking shown for the two concretes, the high value of the modulus of rupture of the gravel concrete as compared to the crushed stone concrete is rather surprising. It has been more or less generally accepted that, other things being equal, the distance between cracks in a plain concrete pavement will be proportional to the resistance of the concrete to failure in direct tension. See "The Interrelation of Longitudinal Steel and Transverse Cracks in Concrete," by A. T. Goldbeck, *Public Roads*, August, 1925. Assuming a general relation between flexure and tension, it was felt that the difference in cracking was probably due to a difference in the flexural strengths of the two types of concrete. This, however, did not prove to be the case, indicating

either that any difference in flexural strength that originally might have existed has been eliminated through the effect of age, or that variations in some other property of the concrete may have caused the marked difference in cracking which was observed.

That this difference is due to some characteristic of the concrete itself and not to other factors, such as variations in subgrade conditions, draining, etc., has been quite definitely established by careful studies of the two 1-mile experimental sections. These two sections, one in Licking and the other in Muskingum County, were separated by several miles. The drainage and soil conditions are, however, very similar. In spite of this, the section containing the gravel concrete had in 1924 more than twice as many transverse cracks as the crushed-stone concrete. The resurvey of these same sections made last year, although indicating that many additional cracks had formed, showed about the same relative percentages as in 1924.

As previously stated, these facts indicate very strongly that some property of the concrete aside from strength influenced the amount of cracking that has taken place on this pavement. It is proposed to investigate various possibilities in this connection, by testing concrete taken from the pavement, and by tests at early ages on concrete specimens made in the laboratory with aggregates from the same sources as were originally employed.

Service record

From the broad viewpoint the most interesting feature in connection with this road is, of course, not the technical question as to the effect of type of aggregate on cracking but rather the excellent service record that has been made by the entire pavement. This road is an outstanding example of the fact that, given materials of satisfactory quality and good workmanship, it is possible to produce pavement concrete that will be as sound and durable, and therefore as permanent as can reasonably be expected. At a time when much is being written regarding the inability of high-type pavements to withstand modern traffic more than a few years without extensive repairs and replacements, it seems important to bear in mind that here at least is one pavement that has given a full measure of service.

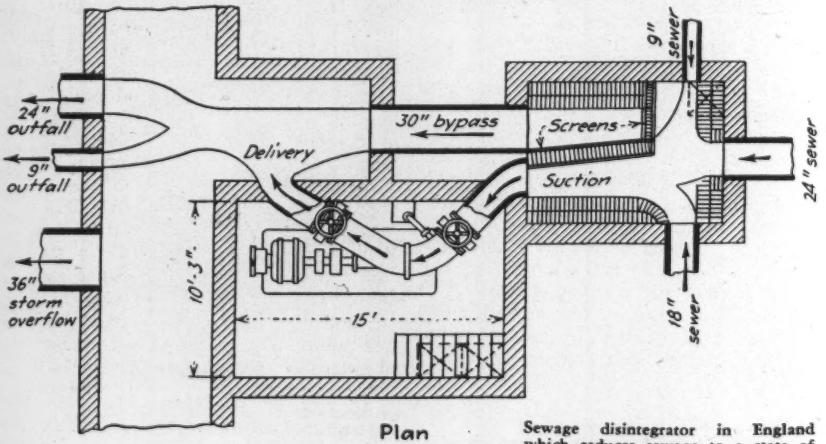
Motor-Driven "Disintegrator" Breaks Up Sewage Solids

MECHANICAL comminution of sewage solids preceding the discharge of the sewage to tidewater is accomplished at Bournemouth, England, by a motor-driven "disintegrator" installed at the outfall. The installation was described in *The Surveyor*, London, Aug. 4, 1933, p. 101, by H. R. Homewood, assistant engineer at Bournemouth.

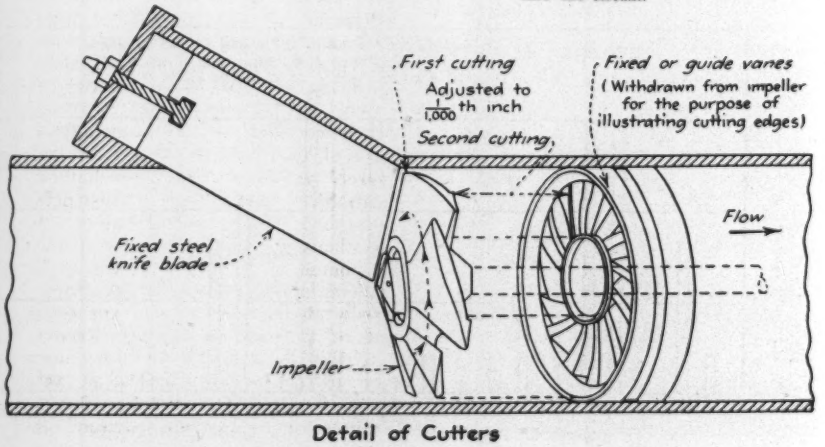
The object of the installation is to break up the sewage solids into particles small enough to prevent fouling of the bathing beaches in the vicinity, at the same time providing more favorable conditions for the action of bacteria. An experiment made at one of the Bournemouth outfalls with an electrically driven disintegrator of the horizontal spindle type was so successful that similar equipment was provided at all other discharge points.

The first noticeable effect of the action of the equipment soon after its operation was the disappearance of hundreds of seagulls who formerly resorted to the outlet. The author of the article in *The Surveyor* states that sewage treated by the disintegrator is reduced to a state of muddy water, organic impurities are rendered innocuous by the natural action of the sea water and its organisms, and when the machinery is running satisfactorily none of the former nuisances has been observed on the foreshore. Bacteriological examinations have been made, and samples taken from parts of the bay used for bathing show to date no bacteriological evidence of pollution.

The cutting action of the disintegrator is of a shearing nature. There are two stages of cutting: the first is between a fixed steel knife blade and revolving blades or impeller; and the second is between the impeller and a set of fixed or guide vanes beyond it. Difficulties were at first experienced by rags getting entwined around the blades and ultimately stopping the machinery, but this difficulty has now been overcome by a slight variation in the blade design. To prevent stones and pieces of concrete from damaging the cutter, the sewage is now allowed to fall into a metal screen in the form of a basket before it enters the suction of the disintegrator. These baskets are hoisted daily and cleaned out.



Sewage disintegrator in England which reduces sewage to a state of muddy water before it is discharged into the stream.



Adapting Public Works to Regional Needs

Activities of PWA Region 10 include use of unemployment figures as a measure of immediate construction needs, and studies of economic areas as basis for comprehensive plan —Volunteer group of specialists assists Regional Adviser

IMPORTANT problems have developed in the work of the regional advisers set up by the Federal Emergency Public Works Administration as a part of its field organization. These problems arise both from the immediate necessity of utilizing construction projects to alleviate distress conditions due to unemployment, and from the requirement that a comprehensive plan be set up for the region in order to adapt the public works program to the most favorable development of the area. The latter requirement is imposed both by the terms of the Recovery Act and by the Administrator's instructions (PWA Circular 1).

In consequence, the work of the regional adviser is assuming much larger proportions than foreseen only a few weeks ago. Special organization and method have been found necessary to cope with it. As outlined in the present article, this is notably the case in Region 10, which embraces the seven states of Delaware, Maryland, Virginia, West Virginia, Kentucky, Tennessee, North Carolina and the District of Columbia, a region extending from the Mason and Dixon line to the southern tier of states and from the Atlantic seaboard to the Mississippi River. The regional office is at Baltimore, under George L. Radcliffe.

Because of the nature of this extensive area, including coastal, industrial, agricultural and coal mining districts, conditions of unemployment and financial resources of the communities vary quite widely. The specific task assigned to the regional adviser is correspondingly diversified and difficult.

Functions of regional adviser

By the terms of the Recovery Act, the Administrator is directed to prepare a comprehensive program of public works and to prescribe rules and regulations for effectuating the public works program, to form a part of the reconstruction plan designed "to increase the consumption of industrial and agricultural products by increasing purchasing power, to reduce and relieve unemployment, to improve standards of labor, and otherwise to rehabilitate industry and to conserve natural resources." The instructions contained in PWA Circular 1 state that the formulation of such a plan "involves consideration of ascertained trends of population and industry, its centralization and decentralization, changes in the habits of the people," and other causes. This task has been delegated primarily to the National Planning Board, which is charged with the duty of developing coordinated plans for regional areas in cooperation with local agencies, based on population and land use conditions, industry, natural resources, and social conditions affecting development plans.

The regional adviser is charged with assisting in the formulation of the regional plan after consideration of state plans, and to stimulate public interest in regional and general planning. He is further directed to advise with the State Advisory Boards—the direct project-handling agencies of the PWA—"to the end that their action may be consistent with sound regional planning." In brief, he is to guide and correlate both the immediate or 30-day emergency works program and a broader program based on the development of state and regional plans.

No provision was made in the initial PWA organization scheme for a staff to aid the regional adviser. Since state planning is practically non-existent however, and the activities of a great many other public agencies must be correlated and extensive data obtained as the basis for developing a plan, staff organization proved an essential first step.

In Region 10, this necessity arose not only from the requirements of broad planning, but also from the immediate and urgent problem of unemployment. In some localities within the region unemployment is of alarming magnitude; several counties are reported to have more than two-thirds of their working population unemployed. Parts of the mining regions are very severely affected. The immediate application of public-works construction to these localities is imperative. On the other hand, in these very districts the communities generally are in bad financial position and cannot afford to borrow the 70 to 75 per cent of the cost of projects which the Recovery Act stipulates. It is therefore necessary to draw into action all other agencies of aid, and mobilize the possibilities of public construction other than that dependent on local participation. The immediate task before the adviser therefore was large and complex and called for competent counsel and assistance.

Volunteer council set up

Mr. Radcliffe brought together a group of volunteer advisers and aids to assist in working out the regional job. This group, which includes several engineers, a leading lawyer of Baltimore, a prominent surgeon and health authority, and a business man, serves as general council to plan ways and means of dealing with the general problem, and also operates as a decentralized working organization in which the field of work is divided up among the members. Theodore E. Straus, business man with engineering training, was assigned the subject of roads; W. Watters Pagon, civil engineer, municipal projects and city planning; Col. J. M. S. Waring, of the engineering firm of Chase & Waring, the economic phases of industries and power; William Gordon Beecher, architect, federal works and housing; John E. Semmes, lawyer, legal questions and general advisory matters; Abel Wolman, engineer of the Maryland Board of Health, water and sanitation; T. Talbot Todd, federal projects; Thomas W. Rogan, general advisory matters; Dr. Thomas S. Cullen, of Johns Hopkins Medical School and member of the Maryland Board of Health, special problems of the Chesapeake Bay watershed.

Office space was donated by the Fidelity & Deposit Co. Here the group meets daily, reporting on progress and considering current problems. The individual members collate data relating to their special fields, analyze them in their bearing on plan and specific projects, and make special studies of particular developments and public works proposals.

Emergency work has priority

It is apparent that the regional adviser has both an immediate and a long-time task set before him. The immediate work is directly concerned with current loan applications and undeveloped projects suitable for such applications, and with the unemployment problem in the region. This emergency work has priority, as against long-time planning; however, even some of the emergency work is closely related to phases of the general planning.

In order to find the points of difficulty, the regional adviser and his council adopted volume of unemployment as criterion of need for constructive measures. Unemployment and relief figures, obtained from federal relief authorities and other sources, showed in what localities unemployment is greatest and where the local authorities are least able to finance new construction. Efforts are now being

centered on developing federal and state work of general-benefit character in or near these localities as a source of construction employment; such work would include through highways, river improvements, reforestation and other development or conservation work, and the like.

Growing out of this attention to the "sore spots" of the region, the work is programmed to include a study of the causes of abnormal unemployment and consideration of general development plans with relation to the industrial and economic conditions of the district in question.

Technical and economic studies

Directly related to the work described is the segregation of specific economic areas forming component parts of the region, to determine their best course of development, resources and population characteristics and other pertinent factors, and to forecast improvement planning appropriate to the area. The West Virginia-Kentucky coal mining districts are being divided into such unit areas. Specific study will be made also of the Delaware-Maryland-Virginia peninsula, a region largely dependent on fisheries and truck gardens.

One area, comprising Chesapeake Bay and its tributaries, has been turned over for separate study to a Chesapeake Bay Commission, set up by the regional adviser under the chairmanship of Dr. Cullen, to give consideration to flood and sanitation problems, shore protection and conservation. Its work may extend also to drainage problems of adjoining marsh lands, with primary view to mosquito control. On Oct. 6 representatives of Virginia, District of Columbia, Maryland, Delaware, New York and Pennsylvania will meet with the commission in Baltimore to consider fully the safeguarding of the purity of Chesapeake Bay.

One important unit of Region 10, the Tennessee Valley Basin, is being dealt with by the Tennessee Valley Authority and thus requires no direct attention from the regional adviser's office. Since it is an essential part of the region as a whole, however, the regional adviser will maintain contact with the plans and development work of the TVA, both for its bearing on employment and for its relation to general plans.

Regional meeting

One of the primary responsibilities of the regional adviser being to correlate the information and activities of all governmental bodies within the region, including the state advisory boards and state engineers of the PWA, Mr. Radcliffe early in his administration called a regional meeting to initiate this coordination. The boards and engineers of all seven states were represented at this meeting in addition to a group from PWA headquarters led by the deputy administrator, Col. H. M. Waite, and the chief counsel, Henry R. Hunt. In a two-day meeting, after first discussing the regional planning in general, the assembly took up the relation of PWA headquarters to the field of organization, and then went into individual state problems in the emergency public-works program. The meeting proved of great value in helping to bring about better understanding of the problems of both state and regional organizations, and brought out the differences in conditions and legislation in the different states that affect the work of the Public Works Administration.

A helpful development with respect to the regional work is the recent appointment by the governor of Virginia of a state planning board, on the suggestion of the PWA state advisory board. This action is particularly important because no other state within the region has heretofore thought of its development as a state-wide problem, and planning has been confined to the work of individual city and district planning boards. An even more immediately constructive step is the decision of the Virginia authorities to proceed at once with a large highway program distributed broadly over the state as an employment measure, separate from and supplementary to the emergency highway program under the $400,000,000 allocation from the Public Works Administration.

Hours and Wage Rates Reported to NRA

Special committee of Construction League compiles data to assist in framing construction code—Wide spread found in wage scales—Working week averages 44 hours

A SPECIAL COMMITTEE on working conditions was appointed by the Construction League of the United States for the purpose of gathering as comprehensive data as possible on current scales of wages actually being paid in the construction industry and to determine the average length of working week. The data secured from the survey, one of the most complete of its kind ever attempted, have been submitted to the NRA as an aid in determining fair wage and hour requirements to be specified in the master code for construction. They are held to support the clauses governing wages and hours proposed in the League's code draft.

The report of the committee, briefly summarized in our news pages last week, includes data on wage scales reported from 500 cities, wage scales being paid on heavy construction as well as on building work, and considerable information on non-union rates as compared with union scales. Both skilled and unskilled trades are considered.

Importance of private construction

The report points out that the federal program authorizing the expenditure of $3,300,000,000 over a period of two years is quite inadequate alone to recreate employment in the construction industry to anywhere near the capacity of the industry. It refers to the severe decrease in construction from 1929 to 1932 and the further decline in 1933, the first half of this year finding construction lagging 35 per cent behind that of last year. Allowing liberally for reduced costs, it is estimated that the industry was employed at about one-third capacity in 1932 and less than that in the first part of this year.

Unless accompanied by a substantial increase in private building and engineering operations, the federal public-works program is not likely to cause the industry to be employed at more than one-half of full capacity, the committee says. Based on present construction activity, and considering half of the federal program as under way the first year, an estimate of the total construction to be done during the twelve months ending June 30, 1934, is $2,610,000,000, including $600,000,000 in private work, $360,000,000 in public works outside the PWA, and $1,650,000,000 in the Federal public works program.

High wages discourage construction

With a view to encouraging and stimulating private construction, the committee recognizes the desirability of establishing wage scales as high as may be economically justifiable, but warns that any arbitrary attempts to set wage scales above levels warranted by current market conditions would be futile. The reasons for this are, first, that scales so established will in many cases

not be adhered to, thus causing the effort to fail, and, second, that private construction operations will be discouraged and recovery hampered. It is pointed out that the emergency program is an artificial market for construction, while the real market, private construction, cannot be restored if labor costs and resulting construction costs are too high.

Wages up sharply in decade

Union wage scales for 21 skilled trades throughout the country during the period 1921-1931 averaged $1.355 per hour, according to the survey. This figure compares with an average of 65.5c. per hour in the 1913-1918 period, and represents an increase of 103 per cent. Wages of unskilled laborers and helpers (five trades) averaged 90.8c. in 1921-1931 and 37.5c. per hour in 1913-1918, an increase of 142 per cent. Construction expenditures in the later period averaged only 77 per cent greater than the pre-war period. The discrepancy between the level of union wages and volume of construction widened greatly with the drop in construction from 1929 to the present date. Wage scales have come down very little in the last four years, while cost of living, building materials, general commodities and construction volume have shown marked declines, as illustrated by the curves below. Average union rates for the period 1921-1931 and the ratio of skilled to unskilled rates for the entire country are shown in Table I.

A comparison of union and non-union wages paid today is shown in Table II, compiled from questionnaires sent out by the Associated General Contractors. Among the various trades covered, non-union scales ranged from 66 to 84 per cent of the union scales for the same trades. The report gives the impression that these non-union rates are closer to the economically justifiable levels than are union scales. The recent wage scales set by the PWA ($1.00 to $1.20 for skilled, 40c. to 50c. for unskilled, depending upon geographical location) are unsound, the report argues.

Reasons for this expressed opinion may be summed up as follows: (1) the PWA scales are based on union rates in the building trades, whereas the bulk (estimated at 70 per cent) of the public-works program will consist of heavy engineering construction, which customarily employs mostly non-union labor; (2) the zone system, based on geographical latitude alone, ignores differentials existing between large cities and small towns, forcing upon Rutland, Vermont, and Sioux Falls, S. D., the same rates as are used in Chicago and New York; (3) the survey of prevailing rates, upon which the PWA scales were based, was incomplete; and (4) even though the PWA scales contemplate a maximum working week of 30 hours, this presupposes a greater continuity of employment than is customary, and does not take into account the necessity of keeping down unit costs, which should be an important factor in public works and is a compelling factor in private construction.

The report points out that it may be difficult but not impossible to apply the PWA rates to public works, but that these high rates are sure to prove a deterrent to private construction, which depends on attracting private capital.

A survey of wages adopted by the various state highway departments for use on National Recovery highway projects revealed that common scales varied from 30c. to 60c., while skilled rates ranged from 37½c. to $1.37½.

Working week exceeds 40 hours

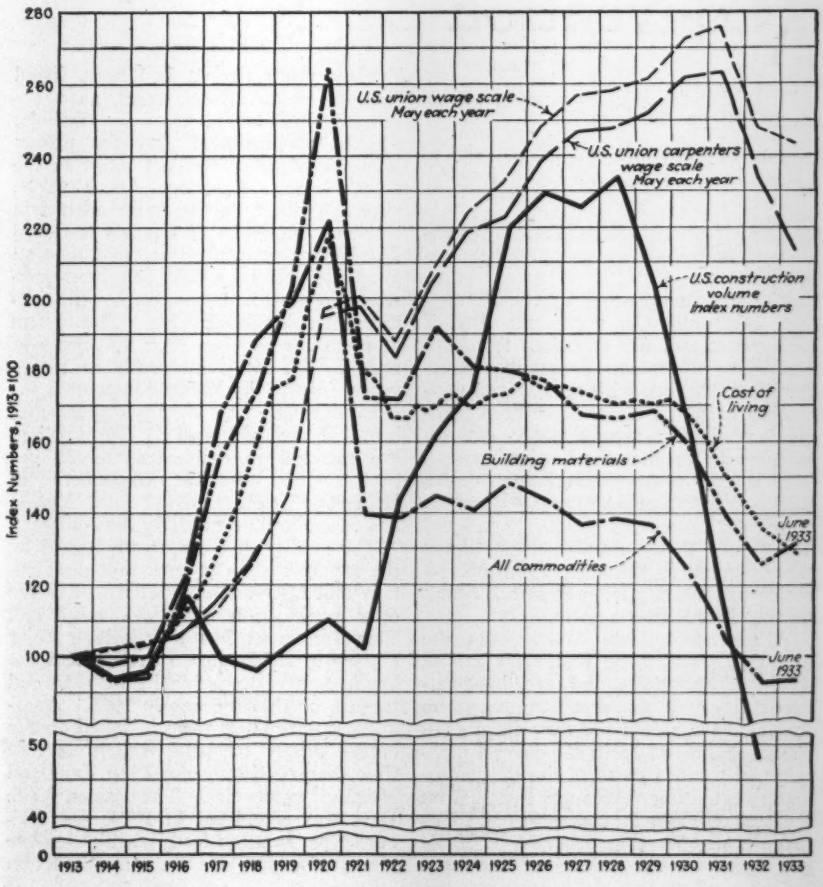
A factory employee working 52 weeks a year at 30 hours per week works a total of 1,560 hours annually. In a fair construction year, a building

TABLE I—AVERAGE UNION WAGE RATES FOR U. S., 1921-1931, AND RATIO OF SKILLED TO UNSKILLED RATES

Compiled by Rhode Island General Contractors Code Committee

Trade	Ave. Rate, 1921-1931	Ratio Skilled to Unskilled*
Skilled		
Asbestos workers	$1.2243	1.492
Bricklayers, general	1.4899	1.827
Bricklayers, caisson	1.7988	2.194
Carpenters, general	1.2249	1.494
Carpenters, millwrights	1.2316	1.502
Carpenters, parq. floor	1.3453	1.643
Carpenters, wharf, bridge	1.1826	1.443
Carpenters, ship	1.0189	1.242
Cement finishers	1.2814	1.562
Composition roofers	1.2182	1.477
Electricians	1.3004	1.586
Electricians, fixture hangers	1.1766	1.435
Elevator constructors	1.3369	1.630
Engineers, hoisting	1.3209	1.611
Glaziers	1.2198	1.487
Lathers	1.3732	1.675
Marble setters	1.3486	1.645
Mosaic & terrazzo workers	1.2290	1.499
Painters, general	1.2681	1.545
Painters, fresco	1.2222	1.490
Painters, sign	1.4765	1.800
Plasterers	1.5011	1.831
Plumbers & gas fitters	1.3212	1.611
Sheet metal workers	1.2397	1.512
Slate & tile roofers	1.4095	1.719
Steam & sprinkler fitters	1.2969	1.582
Stone masons	1.4485	1.766
Steel erectors	1.3344	1.627
Steel finishers	1.3287	1.620
Tile layers	1.3382	1.632
Unskilled:		
Building laborers	.8201	1.000
Comp. roofers' helpers	.7646	.932
Elevator const. helpers	.9565	1.167
Hod carriers	.9494	1.158
Marble setters' helpers	.9558	1.166
Plasterers' laborers	1.0084	1.230
Plumbers' helpers	.9537	1.163
Steam fitters' helpers	.8871	1.082
Tile layers' helpers	.9207	1.134

*Compiled by Bureau of Labor Statistics building laborers' hourly scale = 1.000.



An index of union wage scales, as compared with indexes of cost of living, commodities and construction volume, show that wages have remained at a relatively high level while the other items have gone into a sharp decline since 1928.

TABLE II—COMPARISON OF UNION AND NON-UNION RATES

Trade	Union No.	Union Ave. Rate	Non-union No.	Non-union Ave. Rate	Ratio, Non-union to union, per cent
Bricklayers	97	$1.033	138	$0.826	80
Carpenters	115	.817	272	.604	74
Hoisting engineers	80	.975	124	.648	66
Mixer operators	64	.749	185	.524	70
Shovel operators	34	.990	189	.782	79
Cement finishers	84	.893	194	.570	64
Truck drivers	44	.544	219	.421	77
Struct. ironworkers	65	1.067	63	.744	70
Stone masons	60	1.076	97	.846	79
Tile setters	36	1.013	49	.818	81
Electricians	199	1.002	234	.786	78
Painters & decorators	24	.923	52	.714	77
Steam fitters	108	1.056	96	.887	84
Sheet metal workers	40	.926	30	.777	84
Average, 14 skilled trades	1,050	.948	1,942	.671	71
Unskilled labor	117	.419	376	.339	81

mechanic employed 189 working days under agreements permitting 48 hours of work per week will, at eight hours per day, average 1,512 total hours per year. Under present conditions of employment, few mechanics average 30 hours per week. Consequently, adoption of low maximum working hours involves more serious and complicated problems in construction than in other industries in which employment is less sporadic.

The committee found in its survey that on 59 postoffice jobs out of 118 investigated the work week is 44 hours or more. In an investigation of 491 cities, it was found that the majority of trades work 44 hours or more. The maximum of 40 hours as proposed by the Construction Code would reduce the permitted hours for a majority of workers affected. An opinion is expressed that spreading of work in the construction industry can be much more effectively accomplished by encouraging a large volume of private work than by arbitrarily setting a low maximum for hours of work.

Voluminous data on wages, construction volume and hours of work are given in eight appendices to the report. The chart and two tables accompanying this article are taken from these appendices.

In conclusion the report urges that wages and hours of work in the construction industry, insofar as they are to be provided for in the code submitted to the NRA by the Construction League and in supplementary construction industry codes, be determined principally by consideration of actual wages and hours current in the industry, including both union and non-union scales. Any material increase in rates from those now being paid must discourage an increase in construction activity. This does not imply that the lowest current wage scale should be adopted, but that the scales to be adopted should be related to current market conditions rather than to scales that were current in boom times that cannot be expected to return at an early date.

J. W. Taussig, of the Raymond Concrete Pile Co. was chairman of the special committee that prepared the report. Thomas S. Holden, of the F. W. Dodge Corp., was vice-chairman.

Wide Variety of Topics Discussed at N.E.W.W.A. Convention

Program of the 52d annual meeting made up of papers whose subjects ranged from problems of forestation to the physiology of the olfactory system—modern methods of purification come in for attention

Engineering News-Record Staff Report

THE FIFTY-SECOND annual meeting of the New England Water Works Association was held last week at Bridgeport, Conn., Sept. 19 to 22. A wide range of topics relating to waterworks was discussed at well-attended technical meetings. For the ensuing year the officers selected by the organization were E. Sherman Chase, Boston, Mass., president; Roger W. Esty, Danvers, Mass., vice-president; Albert L. Sawyer, Haverhill, Mass., treasurer. The Dexter Brackett Memorial Medal for the best paper published during the year was awarded to Charles W. Mowry, Boston, Mass.

The Bridgeport water supply

A detailed description of the water-supply system operated by the Bridgeport Hydraulic Co. was presented on the opening day of the meeting. Samuel P. Senior, president of the company, described the system's general features; D. H. Hall, superintendent, described the distribution system; Frank C. Barrows, chemist, the purification methods employed; and William C. Pollitt, engineer, the forestation work of the company.

The system operated by the Bridgeport Hydraulic Co. serves the city of Bridgeport and the suburban towns of Fairfield, Westport, Trumbull, Stratford and Shelton, with a combined population of about 203,000. Three principal reservoirs supply water entirely by gravity to the distribution system. The largest reservoir is Easton Lake, with a capacity of 5,800 m.g. Hemlock Reservoir impounds 3,750 m.g., and Trap Falls Reservoir, the oldest of the three, impounds 300 m.g. Transmission mains run directly from these reservoirs to the distribution system.

A special problem arises from the fact that these three reservoirs are at different elevations and are interconnected through the distribution system itself. To regulate the flow from each source and to maintain the desired pressures in various parts of the city, automatic regulating valves are installed on the transmission mains, adjusted so as to give an operating pressure of 80 lb. per sq.in. at the center of the city. Twenty years ago it had been found that the distribution system, as a result of expansion in a planless fashion, was so proportioned that the proper pipe-line capacity did not exist in the right places. Revisions found to be necessary were thereupon broadened in scope to form part of a newly designed distribution system. Since that time all pipe that has been laid has been governed in size and location by the features of a long-time plan. The system at present comprises over 400 miles of mains, with all joints made in recent years formed by joint compounds instead of lead. Service pipes now being installed are of copper. The services are metered to the extent of 33 per cent, with domestic consumers in Bridgeport itself on a flat rate. Meters are owned and operated by the company.

The quality of the water collected by the supply system is such that disinfection and taste-and-odor control are the only purification processes employed. This treatment has a relatively long history in Bridgeport, starting with the application of hypochlorite in 1911 and the use of chlorine gas in 1916. Automatic chlorinators were installed on the entire supply in 1918, which at that time comprised only the Trap Falls and Hemlock reservoirs. The Easton Lake Dam was completed in 1926, and vacuum-type solution-feed machines were then installed. The use of ammonia in

conjunction with the chlorine was begun in 1932 and is employed during the summer months. Copper sulphate is used for control of algae growths in the reservoirs. The long detention periods provided in the reservoirs materially aid the purification processes.

Forestation of the watersheds is practiced, although not extensively enough to prevent soil erosion or rapid runoff. The principal objects of the work is beautification and the creation of an additional source of revenue from the sale of trees to nurseries and landscape architects. At the present time about 1,700,000 trees are set out, all of soft wood. The species used so far have been white pine, red pine and Douglas fir. The control of diseases and pests has been a serious problem, with white pine being attacked by the pine weevil and red pine by the pine-shoot moth. Douglas fir appears to be more promising in this regard and is to be used extensively next year.

Hydrology of southern New England

An extensive study of the rainfall records for the region from which the city of Hartford takes its water supply has been made by Caleb Mills Saville, chief engineer of the Hartford metropolitan district, who presented to the meeting an abstract of his findings. Briefly stated, the indications are that the low-rainfall period of 1879-1884 was the driest period experienced by this section, but that drought periods of equal or greater intensity are quite likely to recur. The Nepaug source has a rainfall record with a length of 21 years. This is not considered long enough to give the accuracy in prediction necessary in designing water-supply structures.

From hydrology the attention of the meeting was next directed to pipe lines by a paper by Elson T. Killam, entitled "Pipe Linings and Friction Coefficients." This presentation of the subject outlined the specific advantages derived from the use of low-friction, durable pipe linings; the possible use of pipe of smaller diameter because of the greater flow; the higher capacity made possible for a long period, due to the absence of tuberculation; the reduction in pumping costs because of the lower friction head; the more accurate design of systems because the hydraulic features of the pipe remain more constant; the need for flushing is minimized; paving disturbances because of inadequacy in the future are avoided. This paper was discussed by Alexander Potter, New York, who outlined the observations made on tar-dipped cast-iron pipe after twenty years of service carrying sewage. Tuberculation, as it is known in water-supply practice, is absent in this line, although the metal shows serious corrosion, or pitting, where the sewage gases have been active. That part of the pipe which has always been submerged by the sewage shows little damage of any kind. Corrosion has been most active between the points of maximum and minimum depths of flow.

Chlorination practices

In a paper entitled "Modern Water-Chlorination Practice" L. H. Enslow, New York, described the developments in chlorination technique during the past few years and outlined what he considered to be the best practice today. The application of chlorine gas to the water prior to filtration, or prechlorination, is decidedly growing in favor. The reasons for it are good. Prechlorination presents a formidable barrier between the water consumer and possible pollution sources if there should be a breakdown in any of the other plant processes; it also improves coagulation and minimizes operating trouble with filter beds. Ammoniation in conjunction with chlorination, yielding chloramine as a sterilizing agent, has become an accepted purification process, although lower ratios of ammonia to chlorine are now employed than when the process was first put into use. Current practice calls for ratios in the neighborhood of one part of ammonia to four parts chlorine.

Ammoniation technique has also been modified by the growing body of knowledge of the sterilization efficiency of chloramine. Particularly, observations on the lower sterilization rate of chloramine have resulted in the carrying of higher chlorine residuals in the finished water and the provision, when possible, of a longer contact time. An interesting variation in ammoniation practice that Mr. Enslow called to the attention of the meeting is the application of the chlorine ahead of the ammonia. This reverse procedure can be readily applied to waters that do not produce chloro-byproduct tastes; it insures rapid sterilization, then converts the chlorine residual into chloramine for passage into the distribution system. In this way the advantage of ammoniation in preventing aftergrowths in the distribution system can be obtained, without the disadvantage of the slower sterilizing action of the chloramine in the first instance. Prechlorination in conjunction with activated carbon is also widely employed; the carbon removes colloids from the raw water, reducing the chlorine demand by removing much of the organic matter. Carbon dispersed throughout the water, however, does not absorb the residual chlorine.

Typhoid fever outbreaks in New York

Closely associated with the contents of Mr. Enslow's paper was New York State's experience with water-borne disease since 1920, reported by Earle Devandorf, of the New York State Department of Health. A large number of typhoid outbreaks were described by Mr. Devandorf, and it was noted as significant that by far the majority of cases were due to cross-connections between public and private, polluted supplies or by breakdowns in purification methods.

The most severe outbreak in the period reported, and one of the most severe on record, was at Akron, N. Y., in October, 1926. Out of a population of about 2,000, the typhoid cases numbered 284 and resulted in 21 deaths. The outbreak was caused by an insufficient quantity of chlorine being applied to the water, in turn traceable to the absence of tests for chlorine residuals, at a time polluted water from a surface stream entered the well used as a source of supply. Another serious outbreak during this period was at Olean, N. Y., in 1928. In this epidemic there were 248 cases of typhoid, resulting in 41 deaths. The responsibility for this outbreak was likewise placed upon inadequate chlorination at a time when high water in a neighboring stream sent pollution into the submerged well used for the public water supply. The avenue of pollution was a broken connecting pipe in the well. Here, too, records were improperly kept, so that control over chlorination was inadequate. A number of outbreaks were reported among the employees of industrial or commercial establishments, in most cases traceable to the existence of a cross-connection between the piping system of the public supply within the premises and a private system using polluted water for fire protection or process purposes. It was brought out by Mr. Devandorf as noteworthy that typhoid is now considered a compensable disease, the first case decided in this manner being at Amsterdam, N. Y., in 1920.

Discussion following the presentation of Mr. Devandorf's paper served to show that claims paid out by Olean as a result of the epidemic reported above totaled more than $425,000.

Measurement of odor intensity

The natural physiological limitations on quantitative determinations of odor intensities, together with an improved technique for making such determinations, were described by Gordon M. Fair, of Harvard University, in a paper entitled "The Determination of Odors and Tastes in Water." As the basis for the development of a rational method of measuring odor intensities, Professor Fair's study began with the physiology of the olfactory system. Of great importance in this regard is the so-called Weber-Fechner law of sensation, which states that an arithmetic increase in perception must be caused by a geometric increase in the stimulus. In other words, a series of stimuli increasing in intensity by a constant ratio, say 2 to 1, will produce a series of sensations increasing by a constant quantity. In the field of threshold perceptions this means that a barely perceptible

difference in sensation must be caused by a definite fractional increment in the stimulus. Applying this law to the field of odor determinations, and conditioning it by the added fact that the olfactory sense is relatively coarse in distinguishing between odor intensities, Prof. Fair concludes that measurements of intensity must be limited in precision to a 100 per cent difference in the strength of the odor. For the average person, that is, a difference in intensity of 100 per cent in the odor concentration must be present to give a sensible distinction. Consequently, a scale of odor intensities is set up, whose consecutive terms increase in the ratio of 2 to 1, the scale itself consisting of the exponents of 2. The values in this scale series are designated as values of pO, comparable mathematically to the familiar pH values of hydrogen-ion concentration. A pO of 4, for example, means that the odor has an intensity twice that of an odor having a pO of 3; a pO of 3 is twice that of a pO of 2, etc.

To make a practical application of this principle, the technique developed consists of collecting a sample of the vapor of the odorous water and diluting it with odor-free air, volume for volume, as many times as is necessary to arrive at the olfactory threshold. The number of dilutions is then taken as the pO value of the water. Simple laboratory apparatus has been devised to facilitate this determination.

Iron salts in coagulation

Iron salts are regaining in favor in water purification, according to E. L. Bean, of Providence, R. I., who presented a paper before the convention entitled "Advances in Iron Coagulation and Coagulants." Now that differences in cost between iron and aluminum salts have been reduced by methods of manufacture and developments of new coagulants, the greater advantages of iron coagulation were held to be of great significance. Briefly, these advantages include a reduction in the time elements involved in flocculation and sedimentation, and a greater adaptability to varying values of alkalinity.

Administration of waterworks systems came to the attention of the convention in two papers, one entitled "Group Management of Water Companies," by Reeves J. Newson, New York, and one "Municipal Management," by Leland G. Carleton, of Springfield, Mass. According to Mr. Newson's discussion, group management of a number of waterworks systems has the following advantages: more expert type of direction; continuous occupation of the administrative staff, with a consequent reduction of overhead costs; greater breadth of experience in operating problems because of the varying character of the waterworks problems encountered; economies through mass purchasing; uniformity in operating methods; standardization of design elements, yielding lower engineering costs. The disadvantages of group management are: a tendency toward overdevelopment of the central-office staff; discouragement of ambition on the part of the local operating men; the danger of lack of information at headquarters.

Mr. Carleton's paper discussed municipal waterworks administration by using Springfield, Mass., as an example. In that city the water department is autonomous and self-supporting. Its only administrative connection with the city government is through having collections made through the city collector, the invoices paid by the city treasurer and auditing done by the city controller.

The closing session of the meeting was devoted to a discussion of the operation of the National Industrial Recovery Act in stimulating waterworks construction projects. The main presentation of the subject was made by Leslie A. Hoffman, federal public-works engineer for Connecticut and Rhode Island. Mr. Hoffman made a special plea for promptness and completeness of information in filing applications for loans and grants under the provisions of the Act. Advances can be greatly expedited, he explained if the grant only is requested in those cases where the remainder of the financing can be arranged for with private banking sources.

Letters to the Editor

Still Very Much Alive

Sir—I have read with some interest Mr. Dixon's article on "False Wheeler Filter Bottom Used in New Water Plant" in the Sept. 14 issue of the *Engineering News-Record*. On p. 319 I find myself referred to as "the late James E. Williamson."

At the time of the experiments referred to and for five years subsequent thereto, I was engineer and general superintendent of The New York Continental Jewell Filtration Co.

Since leaving the company I have personally pursued the business of designing and installing water-filtration plants and appurtenances, and I trust my many friends interested in such work may not take too seriously Mr. Dixon's reference to me.

Will you be good enough to give prominence to the fact that I am still among the living and operating up to date on the N.R.A.?

JAMES E. WILLIAMSON,
Engineer and Contractor.

New York, N. Y.
Sept. 18, 1933.

* * *

The unfortunate error noted above was ours, not Mr. Dixon's. It occurred through our failure to make a complete substitution of the words "James E. Williamson, then general superintendent" for the words "the late D. C. Williamson, then chief engineer" in the author's original manuscript when making a correction, as requested by the author after it had been delivered to us.

—The EDITORS.

An Engineer Praises Contractors

Sir—In your issue of Aug. 17 I note (p. 204) under the title "Is Time the Essence of a Contract?" a letter signed "A Contractor," in which the rather remarkable statement is made that the construction industry might well be ashamed of its past record of the boom era because of work carelessly done under pressure of time.

I feel that this letter should be answered on behalf of the many contractors who did their work thoroughly and well, and within the times named in their contracts. The writer can cite from personal knowledge a large number of construction projects, primarily highway and railroad bridges, that were constructed thoroughly and well, and were completed and delivered to the owners, in many instances, in less time than the time of completion named in the contracts. All such achievements are the result of well-prepared plans by competent engineers and well-planned execution of the work on the part of the contractor or contractors involved, and there is nothing about any of them that the industry need be ashamed of; in fact, there is every reason why the industry can point to them with great pride.

Of course, time should be of the essence of a construction contract, otherwise the prospective owner of the structure might have to sit patiently waiting for his anticipated returns from the completed structure, or for its use, while the contractor leisurely proceeded to meditate over how he proposed to carry out the work of building it. I might point to the James River Bridge at Newport News, Va., as a single instance of a large construction project, every detail of which was admirably well done as a result of careful planning and programming of the construction work by the contractors, and of perfect teamwork and cooperation between the engineers, contractors and owners. There are hundreds of others.

It is too bad that one who writes such a sweeping indictment of his own industry does not see fit to sign his name.

WILSON T. BALLARD,
The J. E. Greiner Co.,
Consulting Engineers.

Baltimore, Md.,
Aug. 24, 1933

Book Reviews and Notes

A Monthly Commentary on Current Additions to the Civil Engineer's Library

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Air Conditioning

AIR CONDITIONING—By James A. Moyer and Raymond U. Fittz. Cloth; 6x9 in.; pp. 390; line drawings and tables. Published by McGraw-Hill Book Co. Inc., New York and London. $4.00.

Interest in air conditioning has developed rapidly in recent years, but information on the subject has been widely scattered and difficult to find. Pertinent information on the subject is assembled in this book. The first half covers fundamentals, such as air filtration, refrigeration and humidity control, and the second half covers design requirements with typical designs for theatres, restaurants, factories and mills.

* * *

Concrete Highway Bridges

REINFORCED CONCRETE BRIDGE DESIGN—By C. S. Chettoe and Haddon C. Adams. Cloth; 6x10 in.; pp. 400; photographs, line drawings and tables. Published by Chapman & Hall, Ltd., London, 42s.

Written by two engineers of the British Ministry of Transport, this book is planned as a complete treatise on concrete bridges for highway service. Separate chapters are devoted to freely supported spans, continuous spans, arches, portal frames, culverts and substructures. In other chapters such subjects as superelevation, expansion, bridge widening and strengthening and esthetics are considered. Numerous tables and design charts based on British standard practice are included.

* * *

Railroad Research

THE AMERICAN RAILROAD IN LABORATORY—Paper; 6x9 in.; pp. 544; photographs and tables. Published by American Railway Association, Washington, D. C., Chicago, New York. 50 cents.

Frequently it has been said that railroads have been backward in research work, but the statement is based on ignorance of actual conditions, doubtless due to the failure of the railroads to give any publicity to their work, rather than on knowledge of facts. Many civil engineers are familiar with the notable work in the study of stresses in tracks, carried out under the direction of Arthur N. Talbot, and others are familiar with the work done in developing methods of determining defective rails in the track, but few are aware of the existence of the extent of the laboratory facilities at Purdue University for the testing of draft gear and air brakes, and few engineers outside of those in the mechanical field are aware of the great improvement made in locomotive design through continued research by railroads and the locomotive building companies. The book noted here, compiled by the American Railway Association, covers all the many elements of the railroad research work in considerable detail.

* * *

Irrigation Practice

IRRIGATION PRACTICE AND ENGINEERING—Vol. I, Use of Irrigation Water and Irrigation Practice: Second Edition—By B. A. Etcheverry and S. T. Harding. Cloth; 6x9 in.; pp. 256; numerous illustrations. Published by McGraw-Hill Publishing Co., New York and London. $2.50.

The essential features of good irrigation practice are set forth in this revised edition of the first of a three-volume series covering irrigation practice and engineering. The series was first published in 1914-15. The present volume has been entirely rewritten to cover broadened knowledge of the subject and changes in methods of application. Revisions of volumes II and III are planned but have not yet been completed. The treatment of irrigation practice in volume I is limited to the handling and use of water on farms in this country. Similar work in foreign countries is only touched upon because climatic and other differences make experience elsewhere inapplicable.

* * *

Water Towers and Bunkers

REINFORCED CONCRETE WATER TOWERS, BUNKERS, SILOS AND GANTRIES—By W. S. Gray. Cloth; 6x9 in.; pp. 256; halftones, line drawings and tables. Published by Concrete Publications, Ltd., London. 10s.

This volume deals with the design and construction of reinforced-concrete water towers, bunkers, silos and gantries. The treatment of columns subject to wind pressure is discussed; both exact and approximate practical methods are given, covering all the usual cases, including arrangements of columns on concentric circles and polygonal framework without diagonals. Other problems dealt with are the transmission of heat through concrete walls, the design of tanks to hold hot liquids, and the insulating properties of various materials. The calculation of stresses due to hot liquids is discussed. A large part of the book is devoted to construction methods employed in the British Isles and to descriptions of features in completed structures. Descriptions of scaffolding and formwork of all types, including the centering required for tanks with conical floors and bunkers with trough and pyramid bottoms, are presented.

* * *

British Steel Handbook

STEEL CONSTRUCTION: Handbook No. 20-A.—Cloth; 7x9 in.; pp. 327; tables and diagrams. Published by R. A. Skelton & Co., Moorgate Station, Chambers, London. 10s. net.

A new edition of the structural steel handbook of R. A. Skelton & Co., London, made necessary by the adoption of new steel design codes by the British Standards Institution and the London County Council, has just been issued. As compared with the previous handbook, No. 20, the new handbook, No. 20A, contains a new chapter on arc-welded connections, tables on the new safe loads, new data on steel beams incased in concrete, and the Ministry of Transport requirements for highway bridges. The book, containing 326 pages, is thumb-indexed. The price is 7s. 6d. from the company.

New Books and Revised Editions

[Those desiring copies of the books listed below or mentioned elsewhere in this section should order them from the publishers or from their local booksellers.]

FEDERAL PURCHASING—By R. J. Montieth and A. S. Burack. Cloth; 6x9 in.; pp. 349; photographs and illustrations. Published by Bruce Humphries, Inc., Boston. $10.

FEDERAL REGULATION OF MOTOR TRANSPORT—A collection of articles, briefs and bibliographies compiled by Helen M. Muller. Cloth; 5x8 in.; pp. 154. Published by The H. W. Wilson Co., New York. 90 cents.

HYDRAULICS—By Horace W. King and Chester O. Wisler. Third edition, revised. Cloth; 6x9 in.; pp. 292; tables and diagrams. Published by John Wiley & Sons, Inc., New York, and Chapman & Hall, Ltd., London. $2.75.

INTRODUCTION TO INTERNAL COMBUSTION ENGINEERING—By J-B. O. Sneeden. Cloth; 5x7 in.; pp. 268; photographs, diagrams and tables. Published by Longmans-Green & Co., New York and London. $2.50.

PROCEDURE HANDBOOK OF ARC WELDING DESIGN AND PRACTICE—Flexible fabrikoid; 6x9 in.; pp. 434; line cuts, photographs and tables. Published by The Lincoln Electric Co., Cleveland, Ohio. $1.50.

RAYLEIGH'S PRINCIPLE—By G. Temple and W. G. Bickley. Cloth; 6x9 in.; pp. 152; line cuts and tables. Published by Oxford University Press, New York and London. $4.50.

REINFORCED CONCRETE - MECHANICS AND DESIGN—By Robert A. Caughey. Paper; 8x11 in.; pp. 160; tables, line drawings. Published by Iowa State College Book Store, Ames, Iowa. $2.70.

STRESSES IN STATICALLY INDETERMINATE STRUCTURES—By H. Yu. Paper; 6x9 in.; pp. 253; diagrams and tables. Published by National Wuhan University, Wuchang, China. $2 (gold).

A YEARBOOK OF RAILROAD INFORMATION—1933 Edition. Paper; 4x6 in.; pp. 96; photographs, line drawings and tables. Published by Committee on Public Relations of the Eastern Railroads, 143 Liberty St., New York.

Engineering News-Record

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SEPT. 28, 1933 Volume 111 No. 13

No Time to Quarrel

THIS is a poor time for recriminations about public-works delays. No useful purpose is served by charges and counter-charges such as the Conference of Mayors and Secretary Ickes exchanged last Saturday at Chicago, when each attempted to blame the other for delaying municipal projects; better to apply the thought and energy toward getting projects through and pushing them forward to contract and employment. Instead of pointing an accusing finger at the other fellow the disputants should take a leaf from the NRA and display the slogan *"We Do Our Part."* Weekly allocations totaling ten to twenty millions of work, as now being made, are still far too small for the result sought, and the mayors as well as the Secretary have no more important task than to speed up works proposals in order to get the maximum number of workers off the relief lists and on to job payrolls before Christmas. It may be true that the program was delayed at Washington a full two months, but it is also true that the PWA is now in high gear; it may be true that unreadiness of city and state projects contributed additional delay, but it is also true that projects are now coming into Washington at such a rate as to show that the local authorities are active. If both parties will stop quarreling and apply their energy to doing business we can look for real progress.

Rising Costs

IN THE MEANTIME construction costs are rising sharply. The increase since last spring frequently exceeds 25 per cent—considerably more than the *ENR* cost index rise because of stiffening market conditions. This means that the earliest projects to go through will get the lowest costs, which is a further argument for speedy action. But in addition to the cost rise there are contract difficulties. Bidders are reluctant to commit themselves to a fixed job price when everything is pointing upward, when materials commitments are hard to obtain, and when future labor conditions are uncertain. The NRA could do a good deal toward limiting these uncertainties; at least as to material prices a firm attitude would bring prudent business sense back into the psychology of some producers, who now are unable to interpret the code set-up as anything more than a reason for raising prices. Some move toward stabilization of labor conditions also would be timely, for industrial operations are tending to get out of hand in the confusion of wage-rate setting by the NRA and the PWA. Some regulatory action appears inevitable. Moreover, union leaders, who do not lack foresight, are bound to take early action to control the unchecked upward trend of rates, unless they are willing to take the blame for holding up much work. At present, while there is some outlook that the cost rise will be checked, the trend of prices counsels prompt action to get projects going.

Wage Rates and Wages

IN CONNECTION with wage rates one significant point is forcing itself on general attention, now that efforts are centering on increased volume of construction and other capital-goods production. The demand on which such production depends is by no means fixed, like that for bread and bacon and other consumer goods, but depends largely on price. Capital purchases are investments and are discouraged by high prices. Locomotives, factory buildings or houses will not be bought as freely at high prices as at low. Therefore the capital-goods industries must keep their costs and prices down if they are to increase their volume. And for this reason the difference between wage rates and wages under present conditions needs to be kept clearly in mind. When wage rates are raised to the point where they discourage the capital-investing buyer, there will be few buyers, and total wages will be low in spite of high hourly rates. Construction is preeminently subject to this rule during the current campaign for business revival, and for this reason the construction-code rate question is important to every citizen as well as to labor and contractor. If the code rates are placed too high, little will be built outside the public-works program, and that by itself is too small to produce enough employment for recovery. The indispensable support of revived private construction can be obtained only through low wage rates—but high wages.

Constructive Planning Begins

STUDIES begun by some of the regional advisers of the Public Works Administration promise results of great value. Their primary purpose is to guide and assist the development of projects under the emergency construction fund of the Recovery Act, but they have quite as important a long-time purpose. The size and character of the problem involved are well indicated in the present issue by the account of planning in Region 10. Nothing comparable to this type of study has been attempted previously; public construction undertakings have in all but the most exceptional cases been considered and planned singly, without regard to their relation to other projects or their bearing on regional conditions. The new type of planning is certain to be immensely profitable. It substitutes foresight for random or political determination of construction, and so saves the taxpayer money and assures him more efficient and fruitful expenditure of his funds. And, quite as important, it give private industry a surer guide for its future plans, and thus eliminates many serious wastes now inevitable. It will be gratifying to see the same type of planning initiated the country over.

Quantitative Odor Determinations

EMPHASIS in water purification during the past few years has tended strongly toward control of tastes and odors in water supplies. Inevitably the attention of engineers and chemists has been directed toward the knotty problem of measuring the intensity of an odor—knotty because the human nose unfortunately is not equipped with a yardstick. Of great interest in current attempt to make a measuring device out of the olfactory

system is the study reported last week to the New England Water Works Association by Prof. G. M. Fair. Recognized psycho-physical laws are cited to show that the nose cannot distinguish between odor intensities with an accuracy greater than 40 per cent, and in practical routine work it would be necessary to limit precision of measurement to 100 per cent. By keeping this limitation in mind the student of water problems can avoid unjustified preciseness in his recorded observations and minimize discordances in his experimental data. Physiology thus becomes another science to be brought within the purview of engineering activity.

Better Bridge Building

THE BUILDING of big bridges has been such a dominating characteristic of the past decade as to tend to overshadow the remarkable advance made in smaller structures. Under the leadership of the state highway engineers this advance has involved both technical excellence and increased efficiency. One important reason for this improvement has been the initiative shown in treating each location as a special problem. No type of bridge has been barred from examination. Indeterminacy in design has been accepted as just another problem to be solved. Steel, concrete and wood have been given quite dispassionate consideration. The result has been a great number of interesting, useful and economical structures which have advanced the art of bridge building quite as much as have some of the monumental structures. An example is the self-anchored suspension bridge of relatively short span built in the Ozark hills by the Missouri highway department and described in this issue. Not many years ago consideration of such a structure would not have occurred to a designer charged with bridging a narrow stream on a farm-to-market road. But under the new order of things a highly efficient structure over 500 ft. long has been provided at the remarkably low cost of $37,000. Bridge engineering has progressed far since the days when a conventional truss design would have been the only one considered for such a structure. The Missouri engineers kept faith with the spirit of this progress.

The Human Element

A FEW YEARS ago, when the Interstate Commerce Commission was promoting the installation of automatic train control on one or more divisions of each of our major railroad systems for experimental purposes, the railroads strongly opposed making such control fully automatic. They wanted a permissive system, under which the engineman upon coming to a stop signal could pass beyond the signal upon manually operating an acknowledgment button, provided he had reduced speed to a prescribed low rate. This, they claimed, would greatly simplify operating problems by making it unnecessary to bring heavy trains to a dead stop on hills or where traffic was dense and should be kept moving even if at a slow rate. They held that such an arrangement would be just as safe as one requiring a dead stop until the signal cleared, as it would make certain that the engineman knew that he was in an occupied block and that he had his train under full control at slow speed. The argument was logical and was accepted by the I.C.C. in order to minimize the operating difficulties involved in installing automatic train control.

Now comes the first major test of that theory. The Erie wreck at Binghamton occurred in automatic-train-control territory. An engineman of long experience slowed his train down as he approached a stop signal, acknowledged the signal and passed it. Then, however, instead of proceeding with his train under full control he opened the throttle and ran his train into the rear end of a train ahead.

The railroads asked for the continuation of the human factor in train control on the theory that most accidents were due to failure to see signals rather than to deliberate negligence. The Binghamton accident gives strong support to the opposite view. It shows that further elimination of the human element is essential. This may cause delays in train operation, but if it is to result in greater safety the public will be willing to pay the price.

City Distress and the PWA

SOMETHING abnormal has been happening to our cities, to their governing officials and to their financial and economic status. Debt burdens, unemployment, necessity for relief, credit debasement, service curtailment and the businessman's wail for retrenchment and tax reduction have brought officials to their wit's end. Whither will these conditions lead?

To the ordinary layman things seem to be going on about the same as in the past. His garbage is removed, his street lights burn, pure water flows from the tap, and street traffic keeps moving under the corner cop's lynx-eyed control, all as smoothly as in 1929. The city hall still functions; but how long will it continue to do so? Funds and credit have made it function smoothly, and lack of them is likely to produce an opposite result. A bankrupt city, like a bankrupt company, cannot give the same service as a going concern.

Civilization, as we know it, depends on urban life—and seventy million people in this country live in cities. If they are to continue living safely and tolerably in the city hive, maintained community services are absolutely essential. Yet these services are threatened seriously in some of our major metropolitan centers.

The president of the International City Managers Association, C. A. Dykstra, summed up these problems for his associates last week in Chicago, and a three-day conference discussed scarcely anything else. So important was the conference that nearly 25 per cent of all the city managers of the country came to Chicago, followed by a full roster of mayors anxious to thresh out their problems. What these discussions brought unmistakably to light is a tendency of cities everywhere to appeal to Washington and to their state governments for help in their difficulties. But these difficulties can only be solved by a raising of the general economic level, the avowed purpose of the public works act. Instead of cooperating in this endeavor by carrying through local programs of public improvements, the officials look to Washington for relief, for low-interest money, for gifts and grants in aid.

Is the country losing its manliness? Is it conceivable that, even under the generous allotment of the PWA funds, petty politics and inertia should be allowed to paralyze the initiative of public officials? If not, it is time that they exerted themselves to get money for work rather than money for dole! Vigorous work is required to bring the public under the benefits of PWA. Engineers should see that this work is begun immediately.

NEWS OF THE WEEK

Pending Projects Will Take Total of Public Works Fund

WORTHY PROJECTS now in the course of preparation will absorb the $3,300,000,000 public works fund by Jan. 1, according to a report made by Henry M. Waite, deputy administrator of the Public Works Administration to Administrator Harold L. Ickes upon his return from his 6,000 mile airplane trip to visit the regional offices set up by the Public Works Administration. Project applications are being received in increasing numbers by the state boards, he said. In order to speed up the handling of applications forwarded to Washington from the state offices, Administrator Ickes has ordered the Washington office of the Public Works Board to work on a double shift.

Loans and grants authorized for the week ending Sept. 23 totalled nearly $92,000,000, the largest item of which was $54,710,000 for the army housing program. Forty-six non-federal projects totalling over $16,000,000 also were included.

Included in this total is $971,550 for construction work by the Biological Survey, largely for improvements and developments at animal experiment stations, bird and game refuges scattered throughout the country, also $14,800,000 to the Coast Guard for the construction of new revenue cutters, patrol boats, seaplanes and air stations and $15,000 allocated to the Bureau of Plant Quarantine for the construction of a railway car fumigation house in Brownsville, Texas.

Allotments for federal construction include $1,775,000 for the construction of a lock and dam on the Savannah River below Augusta, Ga.; $1,520,000 for a lock and dam on the Cape Fear River, near Wilmington, N. C.; $250,000 for preliminary investigations and plans for the Bonneville dam on the Columbia River in Oregon (the estimated cost of this work is $43,900,000, including a power plant of 450,000 kw. capacity); $53,000 to the Governor of the Virgin Islands for extension of the sanitation system; $60,000 for emergency flood control work in the Rio Grande near San Benito, Texas; and $1,000,000 for a seawall at Fort Monroe, Va. The Bonneville dam study will be carried out by the Corps of Engineers, U. S. Army.

The 46 non-federal projects included in the loans and grants approved during the week ending Sept. 23 are given in the accompanying table.

Army housing

Major items in the allotments for the army housing program include $3,124,000

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DETAILS OF PWA LOANS AND GRANTS FOR NON-FEDERAL WORK

Locality	Type	Loan or Grant	Amount
Davenport Bridge Commission			
Davenport, Iowa	Bridge	L. & G.	$1,446,000
Perry, Okla.	Gas	L. & G.	72,000
Salem, Oregon	Water	L. & G.	1,500,000
Waupaca, Wis.	Sewer	L. & G.	65,000
Board of Education, Oklahoma City, Okla.	School Bldgs.	G.	133,000
Valley City, N. D.	Sewer	L. & G.	77,000
Shawnee, Okla.	School	G.	15,000
Springfield, Ill.	Power	G.	78,000
Springfield, Ohio	Bldg.	G.	7,000
Fremont, Ohio	Storm Sewer	L. & G.	325,000
University of Va., Charlottesville, Va.	Bldg.	G.	38,000
Tappahannock, Va.	School Bldg.	G.	12,000
Chicago, Ill.	Dormitory	L. & G.	2,040,500
Hampton, N. H.	Sewerage	L. & G.	160,000
Evanston, Ill.	Reservoir	L. & G.	250,000
Rosiclare, Ill.	Water	L. & G.	115,000
City of St. Louis, Mo.	Relief Sewers	G.	104,000
Board of Welfare, State of Md.	Bldg. Improvements	G.	64,000
New Trier, Ill.	Bldg.	L. & G.	141,000
Manchester, N. H.	Reservoir	L. & G.	250,000
Des Moines, Iowa	Street Widening	G.	6,400
Des Moines, Iowa	Storm Sewer	G.	80,000
Des Moines, Iowa	Street Imp.	G.	5,500
Des Moines, Iowa	Sanitary Sewers	G.	4,300
Des Moines, Iowa	Culvert	G.	300
Dubuque, Iowa	Concrete Paving	G.	7,000
Dubuque, Iowa	Street Paving	G.	20,000
Dubuque, Iowa	Street Paving	G.	1,200
Dubuque, Iowa	Street Imp.	G.	3,000
Dubuque, Iowa	Boulevard Street Light	G.	6,300
Dubuque, Iowa	Storm Sewers	G.	8,000
Cleveland, Ohio	Sewers	L. & G.	8,990,000
Warroad, Minn.	Park	G.	5,000
Shennandoah, Iowa	Water	G.	38,000
Des Moines, Iowa	Streets	G.	4,000
Pocahontas, Iowa	Streets	G.	6,000
Iowa City, Iowa	Building Repairs	G.	8,000
Iowa City, Iowa	Building	G.	57,000
Franklin County, Iowa	Streets	G.	85,000
Republic County, Kansas	Roads	G.	5,000
Franklin, N. H.	Armory	G.	12,000
Concord, N. H.	State Hospital	G.	31,000
Lewiston, Idaho	Water Works	G.	5,000
Cleveland, Ohio	Incinerator	G.	194,000
Albert Lea, Minn.	Water Works	G.	6,000
Republic County, Kansas	County Road	G.	3,000
Commissioners of Sewage, Louisville, Ky.	Sewage	G.	290,000
		Total	$17,773,500

High Silica Cement to Be Used in Pier of Golden Gate Bridge

A SPECIAL high-silica cement will be used for the south pier of the Golden Gate Bridge according to a 12 to 1 vote of the board of directors of the Golden Gate Bridge and Highway District. Vote was taken after considerable discussion. The use of the high-silica cement was recommended by Joseph B. Strauss, Chief Engineer, and was approved by concrete experts appearing before the board. One of the non-technical issues aired rather fully before the board was the fact that Director Cameron is president of the Santa Cruz Portland Cement Co., which has developed and will furnish the special cement.

The change in specifications will require some readjustment in the agreements for material made by the pier contractor and may even lead to litigation. The contract for the pier construction is held by the Pacific Bridge Co., which has a contract with the Pacific Coast Aggregates, Inc. for supplying mixed concrete. This company, in turn, has an agreement with the Pacific Portland Cement Co. to furnish cement, and the new type of cement cannot be supplied by the latter company.

The recommended change in the cement specifications made by the chief engineer precipitated the matter before the board. The board heard expert testimony on the complicated technical phases of the question, which corroborated Mr. Strauss' recommendation as to the superiority of the high-silica cement for use in sea water. On the question of responsibility which the board might incur by approving the change, an opinion by the attorney held that the district was not liable for the rearrangements required in the subcontracts and that the responsibility that might result from any potential defect in material was not changed.

Fire-Proof House Construction Favored by Public Works Board

To encourage the use of fireproof construction in low-cost housing projects built under the provisions of the recovery act, the special board for public works has decided to extend the amortization period for such buildings to 35 years, permitting the loan to be amortized in 33 annual payments at the rate of 1.51 per cent, beginning two years after loan. Ordinary brick wall construction with wooden floors will be amortized in a 25-year period with annual payment of 0.56 per cent for 24 years. The longer amortization period for fireproof construction applies only to cases where slum areas have to be destroyed before the fireproof building can be erected. Other fireproof construction will be amortized over a 30-year period with 28 annual payments of 2 per cent, beginning after the second year.

City Managers Discuss New Problems Resulting from the Changing Times

RECOGNITION of the newly established relationship of cities to the federal government was the dominant note in the program of the International City Managers Association Sept. 18-20 at Chicago. Problems of finance, such as tax collections and assessing methods, new taxes, refunding bonds, occupied much time. As unemployment relief now is recognized as a permanent burden its administration by public rather than private agencies was considered. Little was said of the details such as work programs. A whole session was devoted to matters pertaining to the city manager as a profession.

This year is the 25th anniversary of the establishment of council-manager government starting at Staunton, Va.; it is now established in 429 cities with 20 per cent of all cities over 10,000 in population so governed. Nearly 25 per cent of the total number of managers were present making the conference the largest in the 20 years history of the association.

New city problems

Few excursions into the technical fields of engineering were made, the managers sticking close to the administrative problems. Commenting on these problems, C. A. Dykstra, city manager, Cincinnati, in his presidential address, stated that: Employment cannot be the care of employers only, unless employers are able to meet the problem of unemployment and relief incident to it. Conversely, if the public is to bear the burden of unemployment and relief it is incumbent on public agencies to interest themselves in employment or the keeping of people at work. Logically this point of view brings public authority into the field of labor and industry. Thus comes relief financed by taxes and administered by public agencies. Meanwhile the federal government for the first time has undertaken to promote public works on a large scale for the states and cities. It has become a banker for the cities to carry out this new practice. Taxing authority is being used to distribute purchasing power so that industry may live.

The effect of NRA on local government will be to increase costs in the field of purchases and contracts thus running counter to the insistent demands for reductions. Wages of public employes, reduced with lowered living costs, to be consistent now must be raised to conform to increased private costs. Cities cannot lag far behind industry in restoring normal wage standards.

In the grip of monetary and capital structure problems facing defaults public administrators have to make the choice as to whether payments shall be made to creditors or whether governmental services shall be curtailed. By which solution will less social damage be inflicted?

Reorganization of functional units and tax allocation is vital to local government for local governments are caught between the millstones of declining revenues and the demand for lower costs. It is the local government which must bear the burden of the increasing complexity of modern life.

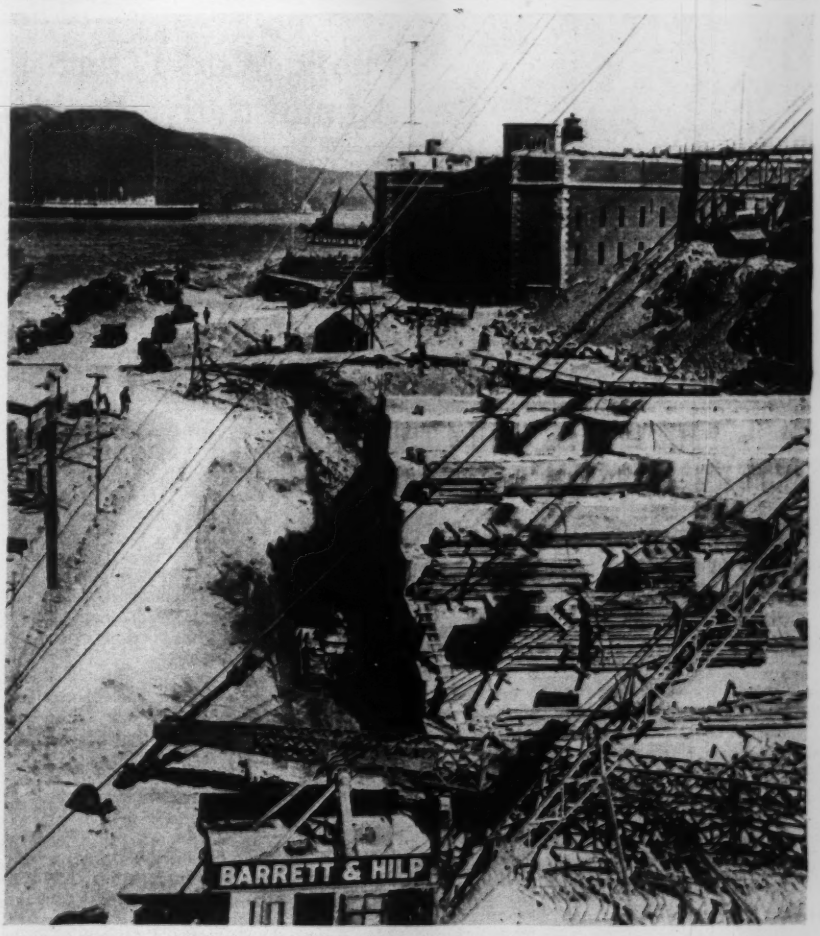
As to the absorption of the surplus of labor released by mass production methods Mr. Dykstra says the service industries and occupations offer the only fields open until population declines instead of growing. Housing sanitation and public health and a large number of individual services need infinitely more attention than they have ever had.

Cities and the federal government

Paul V. Betters, secretary, U. S. Conference of Mayors, spoke on the growing relation between the cities and federal government. Building up this relation will be the dominant thread of legislation in the coming congress.

Louis Brownlow, director, Public Administration Clearing House, Chicago, in indicating methods of keeping the manager abreast of proved administration practices, called attention to the 1,400 organizations treating of the administrative field. When he was a city manager he had 32 journals come across his desk which he glanced through, marking articles for his subordinates to read. Later he would discuss certain of them. This encouraged reading. In discussion, H. L. Wolhiser, city manager, Winnetka, Ill., said that the $150 spent each year for periodicals had not been cut in curtailing the budget in that city.

Answer to the financial hope of the cities, according to Simeon E. Leland, Illinois State tax commissioner, is in collections by the state and federal governments to be returned in larger measure to the cities from which such a large proportion of taxes is obtained. He cited the increased return New York City is getting from the state. It is more efficient for the federal government to do the collecting and the demands for the revenue are increasing in the cities. Not many new sources of taxes are open which will not result in the movement of people and trade. Of the 68 cities which boast of no local taxes but pay for services from profits of municipally owned utilities he said the people were simply being deluded and it was questionable whether there was less equity in overcharging for utility service or in collecting higher taxes for the many municipal services rendered.



SAN FRANCISCO ANCHORAGE OF GOLDEN GATE BRIDGE READY FOR STEEL

The anchorage block for the San Francisco end of the Golden Gate Bridge, shown at the right, is completed ready for the setting of steel. The north pier (showing dimly in advance of the prow of the ship entering the Golden Gate) also is ready. Subaqueous excavation at the south pier is in progress. Except for possible high spots, the underwater blasting at that pier has been completed and the shattered rock has been removed to El.—95. Excavation will stop at this elevation and the fender will then be built around the site. When the pier caisson has been sunk and the rock exposed to examination, preparation for the foundation will be completed.

Harrison P. Eddy Nominated for President of Am.Soc.C.E.

Harrison P. Eddy, senior member of the consulting engineering firm of Metcalf & Eddy, Boston, has been nominated for president of the American Society of Civil Engineers for the year 1934 by a nominating committee consisting of the directors and the two last living past-presidents. The nomination was made during the fall meeting of the board of direction of the society, held in Chicago Sept. 25 and 26. Mr. Eddy has long been active in the affairs of the society. He served as a director from 1928 to 1930 and recently assisted in the preparation of the engineers' code.

Pending Projects Will Take Total of PWA Funds

(Continued from p. 390)

for work at West Point, N. Y., $2,284,000 for Fort Humphrey, Va., $1,786,000 for Langley Field, Va., $1,641,000 for Middletown Air Depot, Pa., $2,190,000 for Barksdale Field, La., $2,267,000 for Fort Bragg, N. C., $6,352,000 for Fort Benning, Ga., $1,650,000 for Maxwell Field, Ala., $2,942,000 for Fort Knox, Ky., $2,735,000 for Patterson and Wright Fields, Ohio, $1,253,000 for Fort Leavenworth, Kan., $4,409,000 for Fort Sill, Okla., $3,825,000 for Fort Sam Houston, Texas, $2,147,000 for Fort Bliss, Texas, $3,536 for Hamilton Field, Calif., $1,085,000 for Presidio, Calif, and $2,458,000 for Ft. Lewis, Wash.

Allotments made to date

Allotments from the $3,300,000,000 public works fund up to September 23 amounted to $1,590,307,706, according to figures compiled by *Engineering News-Record* from releases sent out by the PWA. Of this amount, which approaches half of the total fund, $194,797,900, or about one-eighth, has gone to states and municipalities in loans and grants. Cases where grants alone have been made, without accompanying loans, total $2,704,311. Of the $400,000,000 highway fund, $382,037,753 is reported to have been allotted to the various states and $1,871,062 to Hawaii. Private water companies and terminal market corporations have received loans amounting to $1,017,000. The remainder of the aliotments have gone to federal construction projects, government bureaus and for administrative expenses.

The following table shows the allotments to Sept. 23 according to classes.

ALLOTMENTS FROM THE PUBLIC WORKS FUND

Federal:	
Administrative, etc.	$210,206,741
Part construction	350,901,436
Full construction	399,114,356
To territories	16,335,520
Total, federal work and services	$976,558,053
Highways	$382,037,753
Private corporations	1,017,000
Housing corporations	37,897,000
State and Municipal:	
Loans and grants	192,093,589
Grants only	2,704,311
Total state and municipal	$194,797,900
Grand total all allotments	$1,590,307,706

William M. Black, Former Chief of Army Engineer Corps, Dies

William M. Black, major general, U. S. Army, retired, Chief of Engineers, U. S. Army, during the World War, died at Walter Reed Hospital in Washington on Sept. 24, following an illness of two months. Subsequent to his retirement from active service in 1919, Gen. Black became a member of the consulting engineering firm of Black, McKenney & Stewart, Washington, D. C.

Born in Lancaster, Pa. in 1855, Gen. Black graduated from the U. S. Military Academy in the class of 1873, and after a brief period as an instructor at the Academy, took up the typical life of a young officer of the Engineer Corps. A considerable part of his time during this period was devoted to fortification work and he was largely instrumental in introducing reinforced concrete into the construction of fortifications in this country.

In 1898, while serving as engineer commissioner of the District of Columbia, the Spanish-American War broke out and Gen. Black was appointed chief engineer of the Third Army Corps and, subsequently, chief engineer, Fifth Army Corps. In January 1899, he was named chief engineer officer of the Department of Havana, where he organized the engineering department, cleaned up Havana, repaired the public building and streets and prepared a code of regulations for the conduct of the work which remained in force until incorporated in the general law of the republic.

After the war General Black served for a time as acting chief engineer of the Isthmian Canal Commission, as engineer officer and division engineer of the Eastern Division, and as a senior member of the board charged with removing the wreck of the battleship Maine from Havana harbor.

In March, 1916, General Black was appointed Chief of Engineers, U. S. Army, and as such was active in the organization of the engineer section of the Reserve Corps including the Engineer Officer Reserve Corps. At the outbreak of the World War in 1917, he took personal charge of the organization of the first engineer units of the national army, the nine railway regiments. He retired at his own request in 1919, after the demobilization of the engineer forces of the World War.

Public Works Officials Discuss Administrative Problems of Cities

EXPLANATION of the PWA and its relation to cities, a debate on the contract vs. municipal collection of refuse, incinerator operation, utilizing the unemployed, retrenchment costs, personnel and public relations were the topics of discussion Sept. 21-23 at Milwaukee at the conference of the International Association of Public Works Officials. More than 100 registered. Carl Schneider, New Orleans, is president and is succeeded by T. L. Costigan, Washington, D. C. The next meeting will be held in Rochester, N. Y.

The debate on refuse collection was participated in by Robert B. Brooks, St. Louis, and Bert J. Young, championing the contractors side, and W. J. Galligan, Chicago, J. E. Root, Cincinnati and C. A. McKernan, Utica, N. Y., taking the city side. With rigid specifications, prequalification of bidders, performance bonds and a will to see that the contractor lives up to his contract the contract method was stated to have given good service; in particular this was conceded by the municipal advocates where small cities are concerned. The pre-qualification clause has been adjudicated favorably for New Rochelle by the New York Supreme Court, said Mr. Young.

Speaking in favor of municipal collection, Mr. Galligan held that no single item had in the past influenced politics so adversely as garbage contractors. The system, he said, will be about as good as the local government. In large cities employes can be protected by civil service. Chicago has had municipal collections for 28 years. Mr. Root said the only difference was in how the system was used. The contractor was interested primarily in profits and the city force in service. So regular is the Cincinnati service that complaints come in if the collector is 15 minutes late. Courtesy to the citizen through waste collectors is a potent factor in maintaining the good standing of the administration. Costs vary too much, because of the changing factors in different cities, to use them as any criterion of excellence or desirability of one system over the other. Mr. Brooks stated that the contract system insured a business-like development, that a municipal system usually meant building up a political machine and poor maintenance of equipment because of lack of city funds.

In Utica, said Mr. McKernan, they had finally come to city collection. Contracts could not be made for a long enough period, 3 years, to let the contractor amortize his equipment except at high rates.

Troy, N. Y. has a flexible city system, according to A. E. Roche. Sufficient surplus equipment is available for peaks but utilized on other than collection work in haulage work of miscellaneous materials.

Incinerator operation

Incinerator operation, the only technical topic, brought out results from Racine, Milwaukee, Toronto, Cincinnati, New Rochelle, and Atlanta, Ga. L. L. Hannifin, Milwaukee, said the 1932 costs of garbage collection were 44c. per capita, of disposal, 19.5c. and office 2.6c. These costs are exclusive of depreciation and interest. Atlanta with a 3,396 wet B.t.u. garbage, said H. C. Cates, made sufficient steam sold to a power company to pay 7 per cent on the investment. Cincinnati has had trouble with scavengers robbing garbage of wrappings in the residential districts thus seriously affecting the quantity burned per hour at the incinerator. A new $500,000 destructor of 500-ton capacity is nearing completion in Toronto, which with existing plants will eliminate the "tipping" system.

Work relief in cities

Milwaukee has provided work relief for the unemployed since the winter of 1930-31 when $600,000 was so spent. During the last two years $1,000,000 has been spent each winter. The men work on a half day 4-hour basis and get enough time to make

up the relief allotment of $28.37 per month at 50c. per hour. Street light transformer vaults are now being built. Six hundred men are making a new park but it is found desirable to use a steam shovel in excavating the lagoons. The city has 1,500 men and the county 2,000 relief workers. Some white-collar clerical work is being done in making an alphabetical voting list, also girls are relieving regular nurses in the health clinics for outside work.

Cost of government

Clarence E. Ridley, executive director, the International City Managers Association, spoke on the subject, "The Real Cost of Municipal Government." He came to the defense of the tax spender and outlined clearly the services of government. "Citizens need to balance the budget of their thinking about government and balance the cost of government services against the value of what their services give them." As to the low cost of some of these services he noted an Ohio city of 40,000 getting garbage and rubbish collection at an average total cost of less than 1 cent per person per collection. The real cost, he said, is the excess or unnecessary costs resulting from bad government or the cost that results from a lack of government participation in particular activities. Excess costs include such items as having inexperienced and incompetent administrative officials who in turn appoint equally incompetent subordinates. Poor grade supplies bought at prices above what the best cost is an unnecessary expense. The haphazard and drastic use of the economy axe in some cities is increasing the real cost of government, Mr. Ridley said.

Water Authority for New Jersey Proposed by State Governor

A proposal to set up a Water Authority to develop future sources of water supply for the densely-populated metropolitan district of northern New Jersey is to be proposed to the New Jersey state legislature when it reconvenes in November, according to announcement made recently by Governor Moore. Governor Moore would have the Water Authority apply to the Public Works Administration for a loan of $35,000,000 to finance the construction of additional water supply reservoirs.

Several years ago the New Jersey state legislature set up the New Jersey State Water Policy Commission to study and report upon additional water supplies for the state, and this commission, in 1930, recommended the setting up of three water supply district supported by a $7,000,000 revolving fund to finance new construction as required. (*ENR*, March 13, 1930, p. 458). The commission recommended for the Northern Metropolitan District, the one proposed to be included in the Water Authority of Governor Moore, the construction of four reservoirs costing about $185,000,000.

Sewage Plant for Cincinnati

Construction of a sewage disposal plant to treat the sewage from the city of Cincinnati and from Hamilton county has been recommended to the city planning commission by Myron D. Down, city planning engineer. The commission was expected to take up the proposal at its meeting on Sept. 25.

Flood Control at Pittsburgh Proposed as a PWA Project

Flood control plans for the tri-state district centering on Pittsburgh, Pa., which have been under discussion for many years, are being brought up to date in order to apply to the federal government for PWA funds to carry out the work.

The program calls for the construction of eight reservoirs on the Allegheny and Monongahela rivers, on French Creek and on other smaller streams. The work is estimated to cost $51,000,000.

Plans for Cajalco Reservoir Approved by Engineering Board

Plans for the Cajalco reservoir, one of the storage reservoirs at the western end of the Colorado River Aqueduct, have been approved by the consulting engineering board of the Metropolitan Water District of Southern California. Thaddeus Merriman, chairman of the board, has reported to the directors of the district that the reservoir plans are complete and adequate. The reservoir is at the western end of the main aqueduct, near Corona in Riverside county. From it conduit lines will carry water to distributing reservoirs throughout the metropolitan district.

SOCIETY CALENDAR

AMERICAN ASSOCIATION OF ENGINEERS, annual meeting, Chicago, Ill., Oct. 3-6, 1933.

AMERICAN ASSOCIATION OF STATE HIGHWAY OFFICIALS, annual meeting, Milwaukee, Wis., Oct. 9-11.

AMERICAN INSTITUTE OF STEEL CONSTRUCTION, annual meeting, Chicago, Oct. 17-21.

AMERICAN PUBLIC HEALTH ASSOCIATION, annual meeting, Indianapolis, Ind., Oct. 9-12.

AMERICAN WELDING SOCIETY, fall meeting, Detroit, Mich., Oct. 2-6.

HIGHWAY RESEARCH BOARD, National Research Council, Washington, D. C., Dec. 7-8.

NATIONAL SAFETY COUNCIL, 22nd Annual Safety Congress, Chicago, Oct. 2-6.

NATIONAL ASSOCIATION OF RAILWAY AND UTILITIES COMMISSIONERS, annual meeting, Cincinnati, Ohio, Oct. 10-12.

NATIONAL CONFERENCE ON LOW-COST HOUSING, sponsored by the Cleveland Engineering Society, is to be held in Cleveland Oct. 25-27.

OHIO WATER PURIFICATION CONFERENCE AND THE OHIO SEWAGE TREATMENT CONFERENCE will meet in Findlay, Ohio, Oct. 17-18 and Oct. 19-20.

CONNECTICUT SOCIETY OF CIVIL ENGINEERS will hold a special meeting devoted to the discussion of public works under the Recovery Act on Oct. 3, with afternoon and evening sessions. Both sessions will be held at the Race Brook Country Club in Orange on the New Haven-Derby turnpike.

MISSOURI WATER & SEWERAGE CONFERENCE met at Jefferson City, Mo., Sept. 22-23. On Sept. 23 the afternoon and evening sessions were held jointly with the Missouri Public Health Association.

CANADIAN GOOD ROADS ASSOCIATION held its 20th annual convention at Hamilton, Ont., Sept. 13-14. Among the principal speakers were J. E. Perrault, minister of highways for the province of Quebec, and A. C. Stewart, minister of highways for Saskatchewan; R. M. Smith, deputy minister for Ontario, and David Noonan, deputy commissioner of highways for New York State. Officers elected for the coming year are J. E. Perrault, minister of highways for Quebec, president; G. Shelton Sharp, minister of highways for Prince Edward Island, and A. McMillan, minister of highways for Nova Scotia, vice-presidents.

Personals

DAN I. SULTAN, Colonel, Corps of Engineers, is to be placed in temporary charge of the Rock Island division office.

A. PEARSON HOOVER has been elected a vice-president and director of G. Richard Davis & Co., Inc., builders, of New York City.

CHARLES J. TAYLOR, Major, Corps of Engineers, has been transferred from the Providence, R. I. Engineer District and will serve as engineer, Sixth Corps Area, at Chicago, Ill.

ELROY S. J. IRVINE, Major, Corps of Engineers, is to be transferred from his duties as engineer, Sixth Corps Area, at Chicago, Ill., to become assistant to the division engineer, Pacific Division.

JOHN J. KINGMAN, Lieut. Colonel, Corps of Engineers, has been transferred from the office of the Chief of Engineers at Washington, D. C., to become district engineer at the Providence, R. I. Engineer District.

Z. E. SEVISON, who has been state highway superintendent in Wyoming for a number of years, left that department on Sept. 1. James B. True is now chief engineer and superintendent.

OLIVER H. DICKERSON, formerly principal assistant engineer of the Duluth & Iron Range Railroad, has opened an office for the practice of engineering at 1501 Alworth Building, Duluth, Minn.

Obituary

ALBERT L. SAWYER, registrar of the Haverhill, Mass., water department and treasurer of the New England Water Works Association since 1924, died suddenly on Sept. 23 at Haverhill. He was sixty-nine years of age.

F. R. BISSELL, chairman of the board of the International Cement Corp., died at his home in New York on Sept. 25, age 72 years. Mr. Bissell was educated at Central College, Fayette, Mo., and became president of the St. Louis Portland Cement Co., now one of the subsidiaries of the International Cement Corp., in 1904.

THOMAS J. WASSER, recently named chairman of the Hackensack Valley Sewerage Commission (ENR, Sept. 21, p. 363), died suddenly at his home in Jersey City, N. J., on Sept. 21. Mr. Wasser was 62 years old. At the time of his death he also was clerk and supervising engineer for the Hudson County Board of Freeholders. He has been engaged in state and municipal engineering work in New Jersey for many years, and recently had been most active in advocating attack upon sanitary engineering problems as a regional undertaking. The outcome was the formation of the Hackensack Valley Sewerage Commission of which he was made chairman. Mr. Wasser was a native of Philadelphia and studied engineering in a private school. From 1903 to 1913 he was with the Robert W. Hunt Co. on county engineering work in Hudson County, N. J. In 1913 he was appointed county engineer of Hudson County and with the reorganization of the State Highway Commission in 1920, was made state highway engineer, a position which he held for two years.

Ohio Speeds Municipal Action on Public Works Projects

The Ohio General Assembly has passed a bill reducing the time for placing bond issue proposals on ballot from 60 days to 30 days. The bill has been made an emergency measure to become effective upon the Governor's signature. It was passed at the urgent request of the mayors of eight of the larger cities in order that proposals could be put to the voters this fall in order to get their approval in time to permit the cities to get applications for loans for the projects before the Public Works Administration at an early date.

Sixty One Engineers Get Jobs

Because of the increased work to be handled by the Denver office of the U. S. Bureau of Reclamation, the bureau recently hired 61 engineers. Design work for Boulder Dam is carried on in the Denver office and that office also has been charged with design work for the Grand Coulee dam, for the Casper-Alcova irrigation project and the Seminoe Dam.

Verde River Program Opposed By Salt River Association

By an 18 to 7 vote the representatives of the Salt River Valley Water Users Association, Phoenix, Ariz., opposed the development plans for Verde River irrigation and power project. As an alternative plan they advised, by resolution, that "for the reason that the Salt River project has an insufficient supply of water and there is an insufficient supply of water for the Verde district and the building of such works will deprive us of an adequate supply, the association pledges itself to submit to the shareholders of the association for their approval a plan or plans contemplating the construction of storage facilities on the Verde for the benefit of the Salt River Valley Water Users Association."

The action was taken during a conference attended by representatives of the federal Public Works Administration and the Bureau of Reclamation for the purpose of obtaining local views on the proposed Verde River development. Federal representatives were requested to leave the room while the resolution was under consideration. The question of water rights for the existing Salt River development and the proposed project is in the foreground with matter of disposing of increased hydroelectric power and the production from increased acreage in the background.

Contract Let for Road Bridge to Island in St. Lawrence River

Contract for the superstructure of the Island of Orleans Bridge has been let by the department of public works of the Province of Quebec to the Canadian Bridge Co., Montreal, and the contract for the substructure has been awarded to the Foundation Company of Canada, Montreal. The contracts are for $813,747 and $610,941 respectively. The Island of Orleans is located in the St. Lawrence River, about 4 miles from the city of Quebec. The work now being undertaken is the main river crossing includes a suspended span, the approaches already having been built. The two main piers are being sunk by the pneumatic process and the other four will be built in open cofferdams.

Work is to be begun at once and it is expected to have the bridge completed by the summer of 1935.

Contracts and Capital

CONSTRUCTION

(Thousands of Dollars)

	Weekly Average Sept., 1932	Four Weeks	Week Sept. 28, 1933
Federal Government	$4,670	$6,021	$7,528
State and municipal	15,464	12,412	17,112
Total private	$20,134	$18,443	$24,640
Total private	2,763	8,236	16,566
Week's total	$22,897	$26,669	$41,206
Cumulative to date:			
1932		$914,694	
1933		676,738	

NEW PRODUCTIVE CAPITAL

(Thousands of Dollars)

	Ave., Sept., 1932	Week Sept. 28, 1933
Private and municipal issues	$3,750	$2,100
Federal PWA loans and grants	.....	16,773
Total	$3,750	$18,873
Cumulative to date:		
Total 1932		$532,600
Private and municipal	$262,680	.....
PWA loans and grants	556,458	.....
Total 1933		$819,138

Note—These new capital figures include all private bond and astock issues sold for new productive purposes; all state and municipal bonds sold for construction purposes; all R.F.C. advances made on previous commitments on self-liquidating loans; and loans and grants made by the Public Works Authority to states, municipalities and private corporations for new construction work, including the special highway fund, but excluding all federal allotments from the PWA fund for federal projects that would ordinarily be financed by regular federal appropriations.

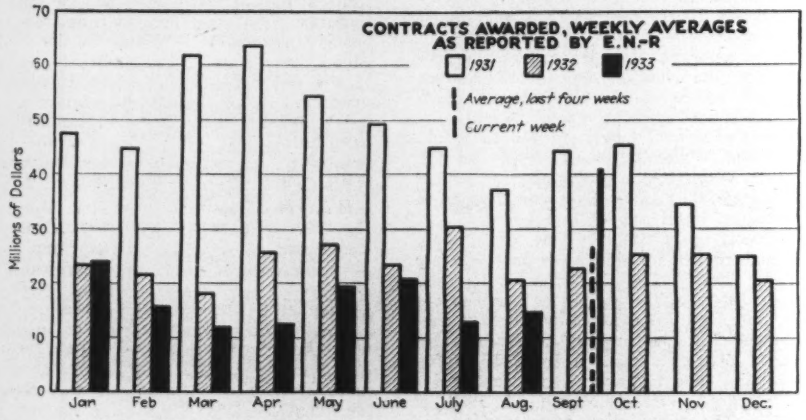
ENR Cost and Volume Index

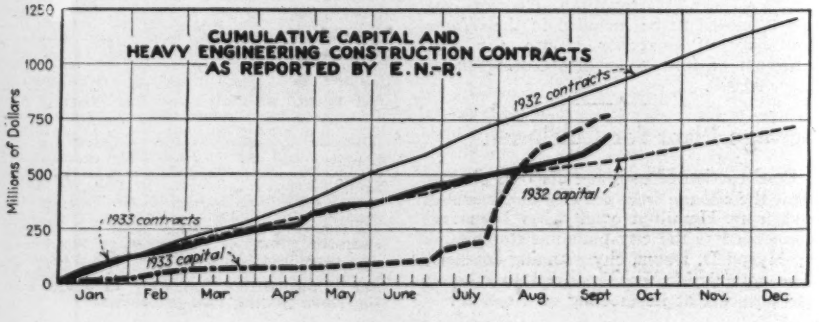
E.N.-R. Cost		E.N.-R. Volume	
September, 1933	175.48	August, 1933	73
August, 1933	167.00	July, 1933	65
September, 1932	157.96	August, 1932	111
1932 (Average)	156.97	1932 (Average)	127
1931 (Average)	181.35	1931 (Average)	220
1930 (Average)	202.35	1930 (Average)	260
1913 (Average)	100		

Engineering Contracts and Capital

FOR THE THIRD successive week, heavy engineering construction awards have jumped $10,000,000 over the previous week, reaching a total of $41,206,000 in contracts reported the past week. This total is the second highest of the year. September contracts averaged $26,669,000 per week, the highest average of any month since July, 1932. Of last week's total, $24,640,000 was for public works and $16,566,000 represented private construction. Private work was the heaviest reported in fifteen months. Federal awards dropped from a high total of 13.3 millions the previous week to $7,528,000, mostly for river and harbor improvement, but still a high figure as compared with federal lettings the past six months. Highway awards reached a high total of the year with $13,524,000. States letting large road contracts included California, $1,913,000; Ohio, $1,561,000; Texas, $1,005,000 and Wyoming, $977,000. Two housing contracts, financed by PWA, in the boroughs of Bronx and Queens, New York City, aggregating 8 millions, a million-dollar brewery in Newark and a 1¼-million dollar publishing plant in St. Louis accounted for much of the private award total.

New capital issues announced during the week total $18,873,000, of which $16,773,000 represents grants and loans by the PWA. State and municipal issues for new productive purposes totaled $2,100,000. No private issues were announced. The cumulative total of new capital to date this year is $819,138,000, of which $556,458,000 is in grants and loans by the PWA.





Construction Equipment and Materials

Manual Support for Trailers

The development of a new improved manual support mechanism for trailers nas been announced by the Fruehauf Trailer Co., Detroit, Mich. The supports are placed well forward on the trailer, giving ample support for the front end when the tractor is uncoupled.

Three sets of ball bearings are used, one on each end of the riser-screw shaft, and one on the inner end of the operating shaft, making it easy to raise and lower the support. In addition, the new supports have the working mechanism fully enclosed. A high degree of safety is provided by the use of a positive-acting riser-screw mechanism. With this system the supports remain in whatever position they are set, making it unnecessary to have a flat surface in order to lower them.

New support for Fruehauf trailers

Self-Cleaning Bar Screen For Sewage Treatment Plants

An improved self-cleaning bar screen for sewage plants is announced by the Jeffrey Manufacturing Co., Columbus, Ohio.

The screen is cleaned by a rake, whose teeth fit between the bars of the screen. The rake spans the width of the screen and its ends are attached to two endless chains traveling in guides fastened to the channel walls. Before turning at the top of the screen to repeat its operation and after having discharged its load, the rake engages a wiper which removes material adhering to it. The wiper is counterbalanced and automatically returns to its normal position. The control mechanism is such that the screen may be operated continuously or at intervals of from two seconds to one hour.

As the return runways are a considerable distance from the screen, the rake enters the channel back of the accumulated refuse. At the final point of its descent, the rake engages the bottom some 2 ft. ahead of the screen. From this position it scrapes toward the screen with teeth dragging on the bottom and comes up under the refuse in suspension. The unit is driven by a 1200-r.p.m. electric motor through a herringbone-gear reducer.

New sewage screen by Jeffrey Manufacturing Co.

New Equipment in Brief

Blasting Cap. A new all-metal delay electric blasting cap is announced by the Hercules Powder Co., Wilmington, Del. The firing and delay elements used produce practically no gas when burning. These features make possible the use of a solid, one piece, ventless shell, which avoids ignition of the dynamite or mis-fire from the entrance of moisture.

Drilling Machine. All steel construction, full crawler mounting, chain drive throughout and dual spring shock absorbers for well drilling are four new mechanical features of a drilling machine recently brought out by the Keystone Driller Company, Beaver Falls, Pa. More than half of the weight of the machine is concentrated in the crawler assembly, which gives a low center of gravity and stability on steep hillsides. Although the machine may be used for drilling larger holes, maximum economy is attained in drilling 6 in. holes.

Waterproofing. The Master Builders Co., Cleveland, Ohio, announces Omicron 4-in-1 waterproofing, which is claimed to have the property of giving impermeability, improved workability, increased strength and resistance to corrosion when used as an admixture for concrete, or mortar. The Omicron ingredient is a highly reactive fine powder grading from 400 mesh to 1,000 mesh, which adds greatly to the plasticity. In liquid form the material is added to the mortar in the proportions of one quart per sack of cement.

Safety Tread. A new type of safety tread composed of Alundum aggregate bonded in a reinforced space of rubber has been announced by the Norton Co., Worcester, Mass. It is designated as the Alundum Rubber Bonded Safety Tread. Alundum aggregate consists of chips or granules of ceramically bonded Alundum abrasive (aluminum oxide) and is extremely hard and tough. It bonds securely with the rubber. The tread is supplied in units of various lengths and widths and can be placed directly over old wood, steel, concrete or stone steps.

New Publications

Air Compressors. Worthington Pump & Machinery Corp., Harrison, N. J., has recently issued four bulletins, designated as W-850-B32, B33, B34 and B37, describing portable air compressors. The bulletins contain 8 pages each and describe machines having capacities of 120, 240, 310 and 360 cu.ft. per min., respectively.

Air Tools. New bulletins issued by the Gardner-Denver Co., Quincy, Ill., include a 24-page bulletin, PBD-100, covering the company's complete line of paving breakers, sheeting drivers, bolt drivers, clay and trench diggers. New folders have been issued illustrating and describing the "90 Series" of lightweight hand held drills; and also the company's 46 lb. sinking drill known as "Model 11."

Steel. Inland Steel Co., Chicago, Ill., has just published a new book planned with particular reference to "A Century of Progess" Exposition in Chicago. Included in the book is a short illustrated history of the development of the company as the Central West developed. Another section gives a well illustrated explanation of the production of steel. Another section illustrates the tremendous diversity of the application of steel in the modern world.

Pumps. Nash Engineering Co., South Norwalk, Conn., has published a new 36-page bulletin describing the Nash vacuum pumps and compressors, the Jennings line of vacuum heating pumps, the Jennings non-submerged type of sump and sewage pumps, the Jennings no-valve pneumatic sewage ejectors, and the Jennings line of self-priming centrifugal pumps. Several entirely new developments are shown, including the staged Nash compressors and vacuum pumps for higher pressures and vacuum.

Business Notes

READING IRON Co., Philadelphia, Pa., announces the appointment of William Craig Wolfe as vice-president in charge of sales. Since 1928 Mr. Wolfe has been general manager of the Highland Iron & Steel Co.

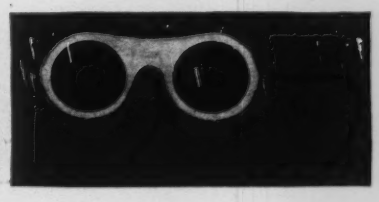
THE POTTSCO CORP., 1 N. LaSalle St., Chicago, Ill., manufacturers of lightweight aggregate, announces that E. A. Randall, of Chicago, formerly associated with Frank Randall, structural engineer, has been appointed consulting engineer of the company, with office at Chicago.

BABCOCK & WILCOX TUBE Co., Beaver Falls, Pa., announces the apointment of T. F. Thornton as sales manager of the Detroit district, with headquarters in the Ford Building, Detroit, Mich. For many years Mr. Thornton has been connected with the automotive and steel industries, and for the past six years he has had charge of the sale of tubular products of the Pittsburgh Steel Co. in the Detroit district.

New Spectacles and Lens For Gas Welders

Latest advances in eye protection for oxy-acetylene welding and cutting have been embodied in the new Oxweld No. 15 welding spectacles and a new lens, Type AA, just announced by the Linde Air Products Co., New York, N. Y. In this new spectacle 50 mm. lenses are mounted in a natural canvas-bakelite frame, permitting a wide angle of vision and increased protection. The temples are covered with insulating material, and the frame is non-inflammable. The new lens is made in light, medium and dark green shades.

Green lenses are mounted in a canvas-bakelite frame



Summary of Principal Unit Prices, 19 Contracts, Colorado River Aqueduct Tunnels

ALL OF THE 29 tunnels, totaling 91.13 miles in length, on the Colorado River aqueduct have been placed under contract, except the 1.79-mile East Eagle Mountain Tunnel, all bids for which have been twice rejected, once last June and again in the Aug. 28 bid opening. Of the 29 tunnels, the Metropolitan District Commission will drive 10, totaling 33.32 miles in length, by its own forces. The remaining 57.81 miles will be done by contract, 19 contracts having been let to date, with the East Eagle Mountain contract yet to be let. The lengh of each of the 29 tunnels is given in table I. Table II designates the contract sections and contractors. The accompanying chart shows the range of unit prices among the 19 contracts for seven principal items common to each section.

Cement is furnished by the District, as are also reinforcing steel, steel supports and miscellaneous iron. Aggregates are furnished at the pits, with a price for overhaul above two miles. Haulage of cement and steel is paid for on a unit price basis. F. E. Weymouth is chief engineer and general manager of the District.

Range of unit prices of principal items, nineteen contract sections, Colorado River aqueduct tunnels. Project numbers on chart correspond to contract sections listed in Table II.

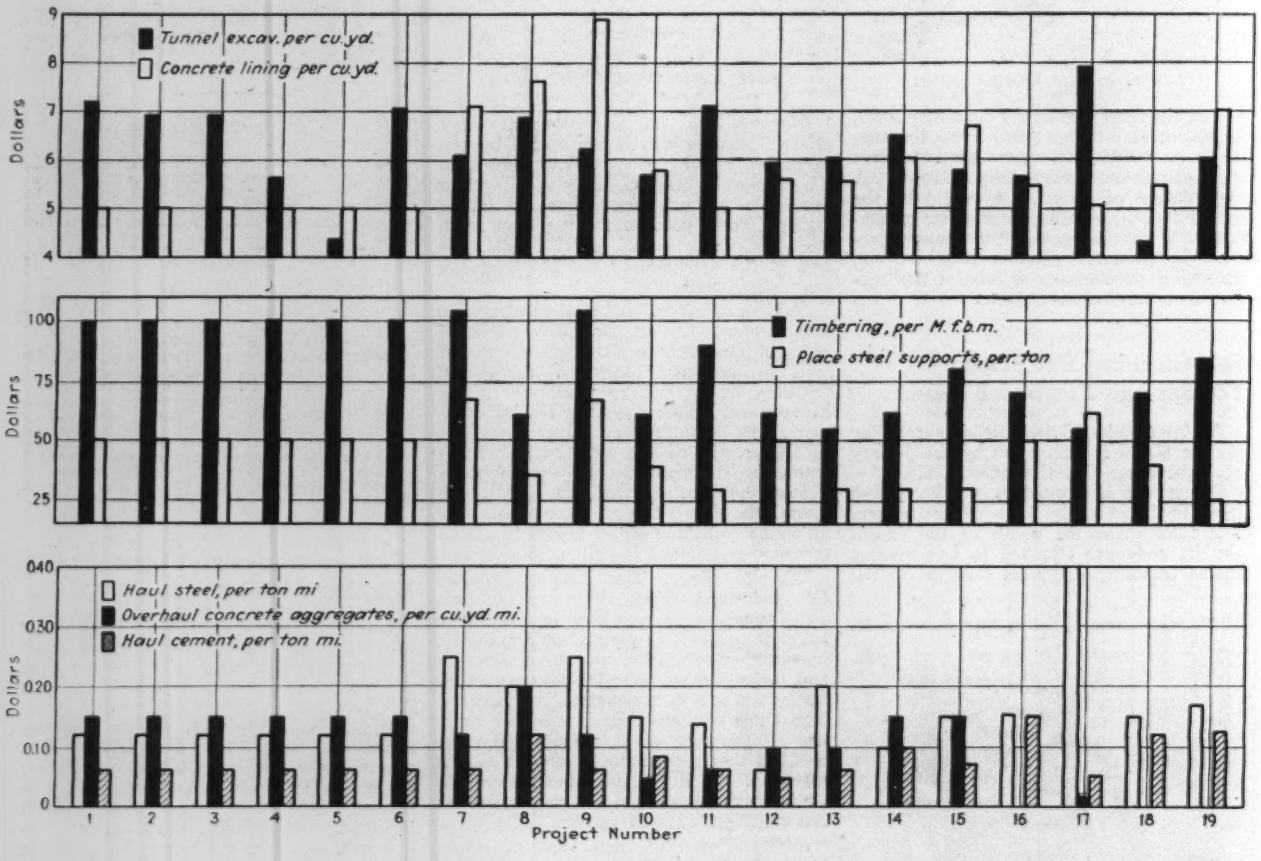


TABLE I—LIST OF TUNNELS AND LENGTH OF EACH

NOTE—Tunnels marked (*) are to be constructed by the District forces by day labor. Tunnels are listed in geographical order from east to west, starting at the Colorado River.

Tunnel	Length, Miles
Colorado River	1.07
Copper Masin No. 1	.14
Copper Basin No. 2	2.18
Whipple Mountain	6.10
Iron Mountain	7.55
Coxcomb	3.32
East Eagle Mountain	1.79
West Eagle Mountain	5.00
Hayfield No. 1	1.83
Hayfield No. 2	1.02
Cottonwood	3.80
Mecca Pass No. 1	.06
Mecca Pass No. 2	.18
Mecca Pass No. 3	.87
*East Coachella	18.24
*Thousand Palms No. 1	2.84
*Thousand Palms No. 2	.71
*Wide Canyon No. 1	2.69
*Wide Canyon No. 2	.15
*Seven Palms	3.15
*Long Canyon	2.88
*Blind Canyon	1.28
*Morongo No. 1	1.04
*Morongo No. 2	.34
Whitewater No. 1	.37
Whitewater No. 2	1.52
San Jacinto	12.75
Bernasconi	1.18
Valverde	7.07
Total length	91.13
District forces	33.32
Contract work	57.81

TABLE II—CONTRACT SECTIONS, COLORADO RIVER AQUEDUCT TUNNELS

Proj. No.	Tunnel Sections and Contractor
1.	Colorado River—Walsh Const. Co., Davenport, Ia.
2.	Copper Basin No. 1, east half Copper Basin No. 2—Walsh Const. Co.
3.	West half Copper Basin No. 2—Walsh Const. Co.
4.	East portion Whipple Mtn.—Walsh Const. Co.
5.	Central portion Whipple Mtn.—Walsh Const. Co.
6.	West portion Whipple Mtn.—Walsh Const. Co.
7.	East half Iron Mtn.—Winston Bros. Co., Minneapolis.
8.	West half Iron Mtn.—Utah Const. Co., Ogden.
9.	Coxcomb—Winston Bros. Co.
10.	East half West Eagle Mtn.—Broderick & Gordon, Denver.
11.	West half West Eagle Mtn.—L. E. Dixon & Bent Bros., Los Angeles.
12.	Hayfield No. 1—Hunkin-Conkey Const. Co., Cleveland.
13.	Hayfield No. 2—Floyd Shofner & J. N. Gordon, Los Angeles.
14.	Cottonwood—J. F. Shea Co., Portland, Ore.
15.	Mecca Pass Nos. 1, 2 and 3—Morrison-Knudsen Co., Boise, Idaho.
16.	Whitewater Nos. 1 and 2—West Const. Co., Los Angeles.
17.	San Jacinto—Wenzel & Henoch Const. Co., Milwaukee.
18.	Bernasconi—Hamilton & Gleason Co., Denver.
19.	Valverde—Dravo Contracting Co., Pittsburgh.